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ENGINEERING • SYSTEMS ANALYSIS • ENVIRONMENTAL SYSTEMS • SUPPORT SERVICES

OAO/TR-81/0052

SPACE TRANSPORTATION SYSTEM FLIGHT 2
OSTA-1 SCIENTIFIC PAYLOAD
DATA MANAGEMENT PLAN

September 25, 1981

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS
WASHINGTON, D.C.

APPROVED

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SECTION 1. INTRODUCTION

SECTION 1. INTRODUCTION

The Space Shuttle, on its second orbital test flight, will carry the first science and applications payload scheduled by the Space Transportation System. This payload, called OSTA-1, has been developed by NASA's Office of Space and Terrestrial Applications (OSTA) to provide an early demonstration of the Space Shuttle's research capabilities. Because the Non-Renewable Resources Branch in OSTA's Resource Observation Division was responsible for Management of three of the seven experiments on OSTA-1, Dr. James V. Taranik, Chief of that Branch was designated Headquarter's Program Scientist for that mission. One of the main responsibilities of the Program Scientist is to insure that a Data Management Plan is developed for the mission.

The characteristics of the second Shuttle flight are described in Table 1-1. During its time in orbit, the Shuttle will assume an Earth-viewing orientation, thus accommodating the experiments of the OSTA-1 payload. In this attitude, called Z-axis local vertical (ZLV), the Shuttle's cargo bay faces the Earth on a line perpendicular to the Earth's surface. The experiments selected for the OSTA-1 payload concern remote sensing of land resources, environmental quality, ocean conditions, and meteorological phenomena. The OSTA-1 payload consists of the following:

Shuttle Imaging Radar-A (SIR-A)
Shuttle Multispectral Infrared Radiometer (SMIRR)
Feature Identification and Location Experiment (FILE)
Measurement of Air Pollution from Satellite (MAPS)
Ocean Color Experiment (OCE)
Night/Day Optical Survey of Lightning (NOSL)
Heflex Bioengineering Test (HBT)

The Announcement of Opportunity for the Shuttle Orbital Flight Test (OFT) flights was released on September 10, 1976. The OFT-2 flight was designated as an earth-viewing mission. The payloads to be considered were categorized as "Class C", that is, an easing of requirements for redundancy, testing, engineering models, and formal failure investigation would

Table 1-1. Characteristics of the Second Space Shuttle Flight

Crew:
Pilot . . . . Navy Capt. Richard H. Truly
Commander . . . . Air Force Col. Joe H. Engle

Cargo Weight Constraints:
OSTA-1 and Pallet . . . . 2443 kg
Aerodynamic Coefficient Identification Package. . . . . 119 kg
Induced Environment Contamination Monitor . . . . 438 kg
Development Flight Instruments . . . . 4556 kg

Launch:
Time . . . . TBD
Place . . . . Pad 39A at Kennedy Space Center

Staging:
First . . . . Solid rocket booster staging at 27 n.mi. altitude
20 n.mi. downrange
SRB splashdown
125 n.mi. downrange

Second. . . . . . . Liquid H_2-O_2 main engine cutoff at 60 n.mi. altitude
720 n.mi. downrange
External tank splashdown near the
antipode in the Indian Ocean

Orbit:

Altitude. . . . . Insertion to a circular orbit of 137 n.mi.

Inclination . . . . $38^o \pm 0.1$

Length of Mission . . . . 5 days

Time in Z-axis Local Vertical . . . . 88 hours

Crew Consumables Contingency Provisions . . . . + 2 days

Landing:
Time. . . . . Daytime
Place . . . . .Runaway 23 at Edwards Air Force Base

be allowed in order to achieve reduction of experiment development expenses. Because of limitations on available funding, encouragement was given for modification of existing instruments. The proposals were submitted by December 3, 1976. Thirty-two proposals for OFT-2 were considered and six were selected by August 19, 1977. Later, HBT was added to form the current complement of experiments for the OSTA-1 mission.

The instruments for five experiments will be located in the cargo bay. A pallet, supplied by the European Space Agency, provides the mounting interface between the cargo bay and these five experiments. The NOSL and HBT instruments will be located in the crew compartment.

Figure 1-1 shows the ground coverage (and resolution) for the five experiments carried in the cargo bay. SIR-A, SMIRR, and FILE are all concerned in various ways with remote sensing of Earth resources, though FILE focuses on the technology of autonomous Earth feature classification and selective data acquisition. MAPS is concerned with remote sensing of environmental quality. OCE is concerned with remote sensing of ocean conditions.

The OSTA-1 Science Management team and Program Management team are summarized in Table 1-2 and 1-3 respectively.

The Shuttle Imaging Radar-A (SIR-A) experiment is the most conspicuous of the OSTA-1 components. Its 9.35-m antenna will send and receive radar signals which will be used to create maplike images of the Earth's surface. The delineation of geological structures from radar data when combined with geological information from Landsat imagery (from the visible portion of the energy spectrum) may be used to develop geologic information helpful in evaluating areas of potentially economic mineral deposits. The SIR-A experiment will be conducted by Principal Investigator Charles Elachi of the Jet Propulsion Laboratory (JPL) and by Co-Investigators Walter E. Brown (JPL), Louis Dellwig (U. of Kansas), Anthony W. England (JSC), Max Guy (France), Harold MacDonald (U. of Arkansas), R. Stephen Saunders (JPL) and Gerald Schaber (US Geological Survey). The Chief Engineer for SIR-A is James Granger of JPL, and he was assisted by Harold Nitschke of JSC.

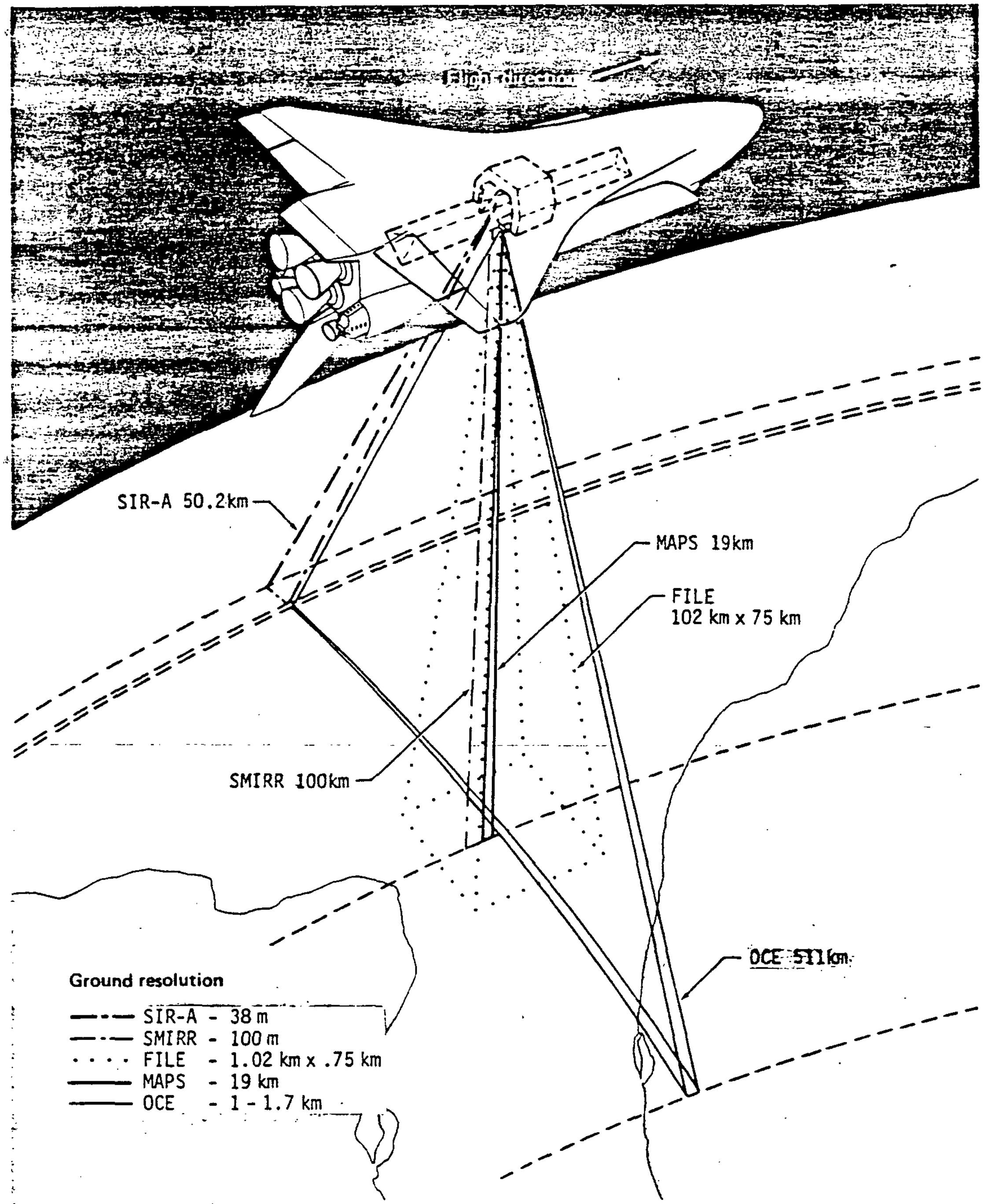


Figure 1-1. OSTA-1 Experiment Ground Coverage and Resolution

Table 1-2. OSTA-1 SCIENCE MANAGEMENT TEAM

PROGRAM SCIENTIST	Dr. James V. Taranik Office of Space and Terrestrial Applications NASA Headquarters Washington, D.C.
MISSION SCIENTIST	Dr. Andrew Potter Space and Life Sciences Directorate Johnson Space Center Houston, Texas
PRINCIPAL INVESTIGATORS:	
Shuttle Imaging Radar (SIR-A)	Dr. Charles Elachi Jet Propulsion Laboratory Pasadena, California
Shuttle Multispectral Infrared Radiometer (SMIRR)	Dr. Alexander Goetz Jet Propulsion Laboratory Pasadena, California
Ocean Color Experiment (OCE)	Hongsuk H. Kim Goddard Space Flight Center Greenbelt, Maryland
Measurement of Air Pollution from Satellites (MAPS)	Dr. Henry Reichle, Jr. Langley Research Center Hampton, Virginia
Feature Identification and Location Experiment (FILE)	Roger Schappell Martin-Marietta Aerospace Denver, Colorado
Night/Day Optical Survey of Lightning (NOSL)	Dr. Bernard Vonnegut State Univ. of New York Albany, New York
Heflex Bioengineering Test (HBT)	Dr. Allan Brown Univ. of Pennsylvania Philadelphia, Pennsylvania

Table 1-3. OSTA-1 PROGRAM MANAGEMENT TEAM

PROGRAM MANAGER	Louis Demas Office of Space Science NASA Headquarters Washington, D.C.
MISSION MANAGER	Gerald Kenney Johnson Space Center Houston, Texas
PROGRAM OFFICE EXPERIMENT MANAGERS:	
SIR-A, SMIRR, OCE	Bruton B. Schardt NASA Headquarters-ERS-2 Washington, D.C.
MAPS	George Esenwein NASA Headquarters -OPG-6 Washington, D.C.
FILE	Charles Fuechsel NASA Headquarters -RSI-5 Washington, D.C.
NOSL	James Dodge NASA Headquarters -EB Washington, D.C.
HBT	Lawrence Chambers NASA Headquarters -SBF-3 Washington, D.C.

Table 1-3. OSTA-1 PROGRAM MANAGEMENT TEAM (cont.)

EXPERIMENT ENGINEERS:

SIR-A	James Granger Jet Propulsion Laboratory Pasadena, California
SMIRR	Mary Brownell Jet Propulsion Laboratory Pasadena, California
OCE	Bert Johnson Goddard Space Flight Center Greenbelt, Maryland
MAPS	W. Donald Hesketh Langley Research Center Hampton, Virginia
FILE	Gordon F. Bullock Langley Research Center Hampton, Virginia
NOSL	Andrew Lander State University of New York Albany, New York
HBT	Edward Peck Johnson Space Center Houston, Texas

The Shuttle Multispectral Infrared Radiometer (SMIRR) experiment is complementary to the SIR-A experiment because both are concerned with geologic mapping from orbital data. The microwave data provided by SIR-A can be used to delineate geological structures, such as faults. The infrared data provided by SMIRR can be used to identify rock types. But SMIRR is not an imaging system, as is SIR-A (and Landsat); its purpose is to find the best spectral bands in which to gather remotely sensed data to distinguish between rock types. Ground-gathered data indicate that significant information can be extracted from infrared spectra for distinguishing rock types. The bands determined by SMIRR could then be included in future spaceborne imaging systems for the purpose of mapping rock types. The SMIRR experiment will be conducted by Principal Investigator Alexander F. H. Goetz of the JPL and by Co-Investigator Lawrence C. Rowan of the US Geological Survey at Reston, Virginia. The Chief Engineer for SMIRR is Mary Brownell of JPL.

The Feature Identification and Location Experiment (FILE) is intended to test Earth feature classification techniques that could, in the future, help such direct sensors as SIR-A and SMIRR find the scenes from which data are to be taken. The enormous quantities of data collected by the three Landsats that have orbited the Earth and the even more mammoth quantities expected from advanced systems demand onboard signal processing to select useful data. FILE technology addresses this type of data management. Using the ratio between visual red reflectance and near-infrared reflectance, it will categorize scenes as vegetation, bare ground, water, and clouds/snow/ice. And it will suppress further data acquisition in certain categories after it has acquired a given number of classified scenes. The FILE experiment will be conducted by Principal Investigator Roger T. Schappell of Martin Marietta (MMA) and by Co-Investigators John C. Tietz (MMA), and W. Eugene Sivertson and R. Gale Wilson (LaRC). Gordon F. Bullock (LaRC) is the Experiment Project Manager.

The Measurement of Air Pollution from Satellites (MAPS) experiment will measure the distribution of carbon monoxide in the troposphere (from 12 to 18 km above the Earth's surface). The performance of the MAPS instrument under various temperatures and other orbital conditions will indicate the

utility of orbiting sensors for measurement of environmental quality. The MAPS experiment will be conducted by Principal Investigator Henry G. Reichle, Jr., of NASA's LaRC and by Co-Investigators William L. Chameides (Georgia Institute of Technology), W. Donald Hesketh (LaRC), Claus B. Ludwig (Photon Research, Inc.), Reginald E. Newell (MIT), Leonard K. Peters (U. of Kentucky) Wolfgang Seiler (Germany), John W. Swinnerton (NRL), H. Andrew Wallio (LaRC), and Sherwin Beck (LaRC).

The Ocean Color Experiment (OCE) will scan the ocean to detect areas where a high concentration of chlorophyll-bearing algae shifts the pure blue of ocean water to greenish. Information on the distribution of algae can help locate fish schools or track ocean currents using the chlorophyll pigment as tracers. Considerable experimental effort will be spent eliminating the effects of surface reflections and atmospheric scatterings that obscure the detection of ocean coloration. The OCE will be conducted by Principal Investigator Hongsuk H. Kim of Goddard Space Flight Center (GSFC) and by Co-Investigators Lamdin R. Blaine (GSFC), Robert S. Fraser (GSFC), Norden E. Huang (WFC) and Heinz Van der Piepen (Germany). The Chief Engineer for OCE is Bert Johnson of GSFC.

The Night/Day Optical Survey of Lightning (NOSL) will involve the crew in taking the first motion pictures and photocell readings of lightning and thunderstorms from orbit. Data obtained from this unique vantage point will be analyzed in the hope of developing techniques for identifying severe weather situations from meteorological satellites. The NOSL will be conducted by Principal Investigator Bernard Vonnegut of the State University of New York at Albany and by Co-Investigators Otha H. Vaughan, Jr. (MSFC) and Marx Brook of the New Mexico Institute of Mining and Technology.

The Heflex Bioengineering Test (HBT) is a preliminary step in leading to a plant physiology experiment scheduled for Spacelab 1. The HBT hardware consists of a container of planted pots with varying soil moisture levels. The technical objective of the Heflex Bioengineering Test is to determine the relationship between initial soil moisture content and final plant height after growth in a microgravity environment. The results will help determine the optimal soil moisture conditions for the Spacelab

experiment. The HBT will be conducted by Principal Investigator Allan H. Brown of the University of Pennsylvania and his colleagues.

SECTION 2. BACKGROUND

SECTION 2. BACKGROUND

In this section, for each experiment, the goals or objectives of the experiment are given, along with the criteria against which the overall performance of the experiment will be assessed. The experiment goals are summarized in Table 2.0-1.

2.1 EXPERIMENT OBJECTIVES AND MINIMUM EXPERIMENT PERFORMANCE

2.1.1 SIR-A

The objectives of the Shuttle Imaging Radar-A (SIR-A) experiment are to evaluate the potential of spaceborne imaging radar in geologic mapping and to determine the synergism of using radar imaging in conjection with Landsat imagery for Earth resources observations.

The minimum experiment performance for the SIR-A experiment is:

1) Transmitted peak power in excess of 300 watts.

2) a median signal to noise ratio of 10 dB. This will be verified by the engineering data which provide the average of the echo power and the receiver noise power.

3) Two hours of data acquisition time. This corresponds to a total coverage of 2.5×10^6 km^2.

2.1.2 SMIRR

The Shuttle Multispectral Infrared Radiometer was proposed to meet the following objectives:

1. Obtain radiometric reflectance measurements in 10 wavelength channels between 0.5 and 2.5 μm of selected portions of the Earth's surface.

2. Assess the value of very narrow spectral channels (0.02 μm) for mineralogic and lithologic identification from orbit.

Table 2.0-1. OSTA-1 Experiment Potential Applications

EXPERIMENT	POTENTIAL APPLICATION
SIR-A	Analysis of Topography and Morphology for Geologic Investigations
SMIRR	Improved Rock Type Classification
FILE	Vegetation, Bare Ground, Water, and Clouds/ Snow/Ice Categorization
MAPS	Carbon Monoxide Measurements in the Troposphere (up to 18 km Above the Earth's Surface)
OCE	Oceanic Chlorophyll Mapping
NOSL	Lightning and Thunderstorm Investigation
HBT	Effect of Zero-G on Soil Moisture and Plant Growth

3. Assess the value of the 10 chosen wavelength channels for use in future imaging systems for geologic mapping.

4. Assess the variability of reflectance signatures of major rock types from portions of the earth as affected by environmental conditions.

5. Determine the correlation between ground-based reflectance measurements and SMIRR orbital measurements.

The minimum experiment performance for SMIRR is defined as follows:

1. One camera operational during data takes
2. Cover open for data takes
3. Detector at temperature
4. Detector within 20% of sensitivity measured in June 1981
5. Bit error rate less than 10^{-4} as measured on the CCT's
6. One hour of cloud-free data acquisition

2.1.3 FILE

NASA has a goal of providing a 1000-fold increase in the ability to obtain useful data from space without increasing the cost of obtaining the data. The FILE experiment represents one step in a technology-development effort directed toward providing improved data selectivity (at sensor stage) in space, and therefore, the ability to obtain a given amount of useful data while reducing the volume of associated data handling and management. Early emphasis is on techniques for Earth terrain classification. The technology development effort of which FILE is a part at the same time addresses the NASA goal of making useful space data available more quickly to the data users, and in real time when timeliness is essential.

The specific objective of FILE is to test a technique for autonomously classifying Earth's features into four categories: water, vegetation, bare land, and clouds/snow/ice. Autonomous (on-board) feature classification is recognized as a logical first step toward improving data management for many Earth observation space missions. Autonomous feature classification provides the basis for further remote sensing advancements, including the

acquisition, or reacquisition, of given landmarks (features), boundary or feature tracking, and navigation via landmark recognition.

The instrument has been designed to perform the following functions during the mission:

- o Record two-channel digital image data.
- o Record 70-mm photographic images
- o Record real-time feature pixel count.
- o Record high or low cloud reference.
- o Record GMT for images.

2.1.4 MAPS

The MAPS experiment will measure the distribution of carbon monoxide (CO) in the middle and upper troposphere. (The troposphere extends from the Earth's surface to the stratosphere, i.e., to an altitude varying from 12 to 18 km.) The major technical objective of the experiment is to evaluate the performance of the MAPS instrument in actual operation under various temperatures and other environmental conditions encountered during space flight. The measurements of the CO concentrations will be used to determine the interhemispheric mass transport of the gas and to verify two-and three-dimensional chemical transport models. Furthermore, the experiment will allow the MAPS sensor to be evaluated as a possible long term monitor of changes in the tropospheric CO distribution and the evaluation of techniques and procedures for the accumulation, classification, and analysis of global data.

The MAPS experiment will be considered 100 percent successful if high quality CO measurements are obtained in 50 percent of the 288 10° latitude by 10° longitude areas that underlie the orbital track. A high quality CO measurement is one of 20 seconds duration made through an air column free of mid- and high- altitude clouds and having a signal-to-noise ratio of 20 or greater.

2.1.5 OCE

The primary experiment goal of the OCE is to validate the remote sensing technique of multispectral scanning for evaluating marine bioproductivity. The secondary goals are to derive oceanic circulation patterns, and the presence of pollutants in the scanned areas. These will be accomplished by collecting ocean color data, distinguishing it from obscuring surface reflections and atmospheric scatterings, and reducing the data for the production of chlorolphyll maps in selected areas.

The OCE will avoid the special problems presented by coastal waters and concentrate on deepwater areas on the eastern side of both the Atlantic and the Pacific Ocean. At these positions, in nutrient-rich, water-upwelling zones, there is low sediment suspension and negligible seafloor reflectance. However, the problem of obscuring radiation remains. Only ten to twenty percent of the radiation emanating from the body of water and received by the instrument will be useful information. The rest will be light scattered by air molecules and aerosols and reflected directly off the ocean surface. Thus, much of the effort involved in this experiment will be the scientific analysis of the effects of atmospheric aerosols, sea state, and sun angle. Figure 2.1.5-1 shows schematically the sources of energy sensed by the OCE.

Three in-situ data collection sites have been selected to back up the spaceborne OCE; these are: 1) off the coast of Senegal, W. Africa or alternately, the coast of Spain, 2) the mid-Atlantic, and 3) Southeastern U.S. Atlantic bight. The objectives of these measurements are respectively to 1) study plankton populations in upwelling areas, 2) study warm core rings and 3) study the biota and dynamics of upwelling along the western edge of the Gulf Stream and perform a comparison study between sections across the Kuroshio and Gulf Stream.

The success of the OCE will largely depend on how many minutes of useful ocean colorimetric data can be collected during the five day mission. Presently about 120 minutes of viewing time is assigned. However, if the mission produces 40 minutes of OCE data under fair weather conditions, this experiment will be considered a success. This figure amounts to only 33%

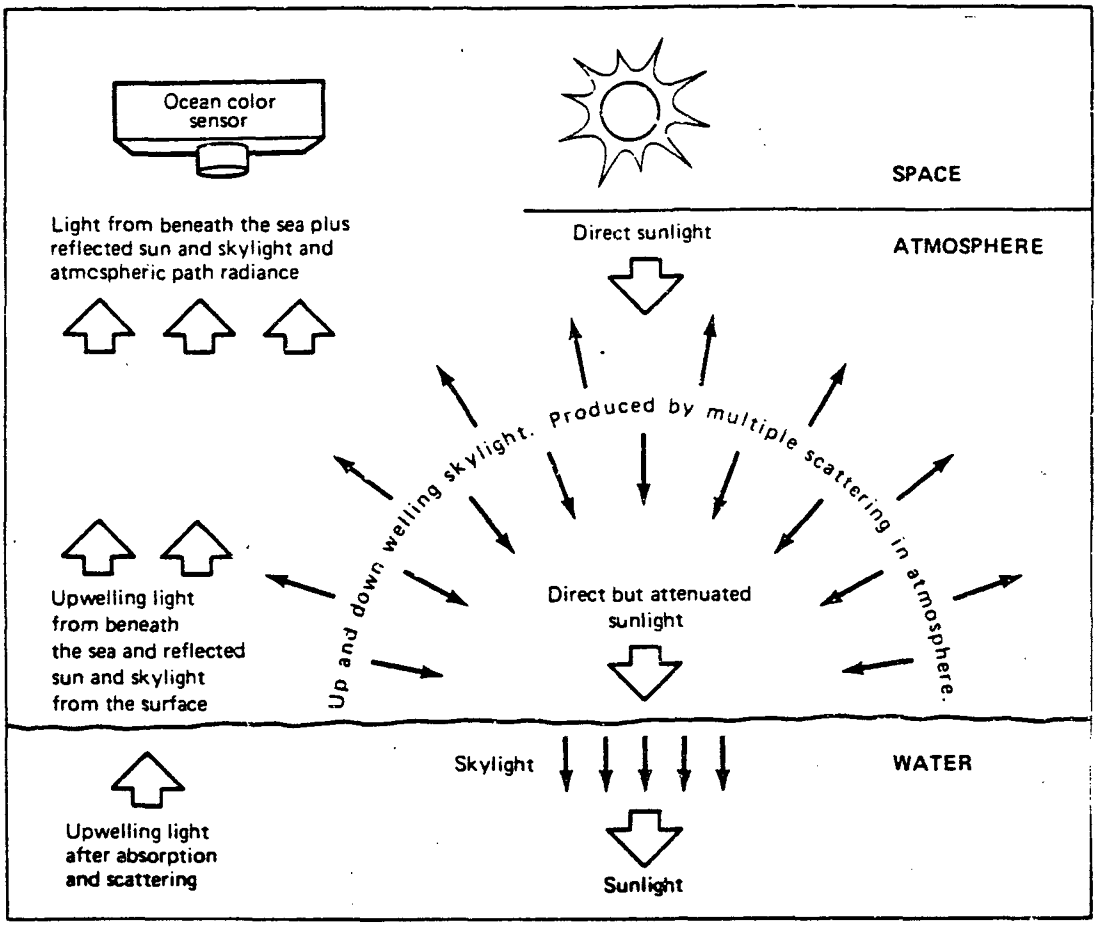


Figure 2.1.5-1. Energy Sensed by the OCE Instrument

of the original goal, but the percentage is not unreasonable when one considers the fact that in ocean data collection, the probability of having fair weather over a predetermined target site on a given day is rather small.

Another aspect to be considered is the quality of the OCE data. OCE data-taking is strategically planned so that the data can be useful not only for mesoscale case studies but also for future colorimetric data processing algorithms study. OCE has a total of eight predetermined test sites. Repetitive coverage of each test site is planned so that at least one set of OCE data will be acquired for each test site. However, successful repetitive coverage of a site means that the particular data set can be used for studies relating to the flow dynamics of the area in a time series manner.

The next criterion to be considered is how useful the acquired data are for studies relating to the atmospheric effects and chlorophyll analysis. For this purpose, it is desireable that the data from the Orbiter contain several different values of atmospheric aerosol values ranging from an aerosol optical thickness, τ_{Mie}, of zero (Rayleigh sky) to a τ_{Mie} of 0.2, and a variety of chlorophyll values ranging from near zero to several mg/m^3.

In summary the success of the OCE Mission will be considered according to the following criteria:

Criteria	Levels to Meet the Success Criteria
a. Frequency of successful	33% of original data plan completed data gathering events
b. Case studies involving each test site	One set of data for each site
c. OCE data for algorithms validation	The total data includes: a) Atmospheric aerosol parameters from τ_{Mie} = 0 to 0.2 b) Chlorophyll concentrations from zero to 5.0 mg/m^3

2.1.6 NOSL

The objective of the Night/Day Optical Survey of Lightning (NOSL) is to obtain motion picture film and correlated photocell sensor signals of lightning storms. The information obtained will not only shed new light on electrical charging processes in thunderstorms, but will lead to the development of the Night/Day spaceborne lightning detection system.

NOSL will use a motion picture camera to obtain films of ordinary and severe thunderstorms, which will provide information on storm dynamics and electrical phenomena. In addition to film records of the appearance of cloud systems and lightning, the detailed structure of the lightning discharges will be recorded by a photocell optical system, which also generates an audible pulse tone in response to the detection of a lightning flash. While the motion picture camera will not be able to photograph lightning during the day, the photocell optical system will be capable of detecting and providing data on lightning in daylight, even from clouds illuminated by direct sunlight. The photocell optical system data will be recorded on magnetic tape.

A lightning event which appears visually as only one flash is usually composed of many separate discharges, called strokes, that can be detected by the photocell. In this way, the frequency of the lightning and its characteristics during day or night can be correlated with the cloud structure and the convective circulation in the storm. The adaptation of these techniques may prove to be useful for identifying severe weather situations from meteorological satellites. The following are features of thunderstorm activity that will be of particular interest:

a. Long Lightning Discharges. There are a few reports in scientific literature describing both visual and radar observations of lightning discharges of unusual length, sometimes as long as 150 kilometers. Photographs of such discharges would be of considerable scientific value.

b. Unusual Lightning in Tornado-Producing Storms. Airline pilots flying in the central U.S. have stated that they often can

identify tornado-producing storms by the very unusual lightning phenomena they produce. Although no photographs of this activity have apparently been taken, the descriptions indicate unusually frequent lightning and sometimes lightning of various colors. Photography of this unusual lightning activity would be a valuable contribution to our understanding of tornado-producing storms.

c. Electrical Discharges in the Clear Air Above Thunderstorms. Observations of thunderstorms, particularly of the more intense variety, sometimes include descriptions of electrical discharges unusual in that they are occurring not beneath or within thunderclouds, but in the clear air above them. Such descriptions include not only what are apparently normal lightning discharges (except for the fact that they extend upwards into the clear air of the stratosphere above the cloud), but also luminous pillars of light and glowing fireballs. At present there are no photographs of this phenomenon, and it would be of great value if pictures could be obtained from the Space Shuttle.

d. Changes in the Reflection of Sunlight from the Upper Part of a Thundercloud as a Result of Electrical Reorientation of Ice Crystals. There have been a few observations made from the ground and from high altitude aircraft above thunderclouds, showing that the intensity of the sunlight reflected from the upper part of the cloud can suddenly increase or decrease following a lightning event. This effect is probably produced by electrically induced reorientation of ice crystals and would occur when the direction or intensity of the electric field changes as the result of lightning.

e. Cloud Circulation. Despite the brief time that strongly convective cumulonimbus clouds will be in the field-of-view of the observer, it may be possible to recognize interesting cloud motions. Observers should make note if they recognize regions of convergence and divergence in thunderstorm cloud areas and perhaps regions of strong rotation. If these can be documented by

the camera, it will be of considerable value to students of storm and cloud dynamics.

There are separate criteria for the success of the instrument, the mission, and the proposed experiment. For the operation of the instrument to be considered a success, the camera must expose the film properly, the lightning flash detector must operate unambiguously, the two-channel tape recorder must record both sensor "clicks" and voice records, and astronaut notes must allow location of the photographed events.

For the mission to be a success, the astronauts would have to photograph and record lightning sources on at least two overpasses (30 sec) by day and two overpasses by night for each of the following phenomena: isolated thunderstorms, frontal or cluster storms, hurricanes/typhoons, the Inter-tropical Convergence Zone, and organized convection over Florida, South Africa, and Indonesia. Certain unscheduleable observations would make the data scientifically highly interesting and valuable. These include chance observations of long discharges, convective storms, stratospheric discharges, and lightning associated with volcanic eruptions.

For the total experiment to be an unqualified success, subsequent missions should be used to observe intense spring season thunderstorms in the U.S. Midwest, peak season South African thunderstorms, "inverted" warm-cloud thunderstorms in winter over the Sea of Japan, and to collect adequate observations for statistically significant studies of hurricane/typhoon lightning occurrences, stratospheric lightning and long connected discharges.

The success levels for NOSL data collection are given as follows:

Success Level	Data Collection
65%	Obtain nighttime lightning photographic data
75%	Also obtain nighttime photocell data from lightning
85%	Also obtain daytime convection storm photography
95%	Also obtain daytime photocell data from lightning

2.1.7 HBT

The Heflex Bioengineering Test (HBT), unlike the other components of the OSTA-1 payload, is a preliminary test that supports a subsequent experiment called Heflex (Helianthus Annuus Flight Experiment) which will be flown on the planned Spacelab-1 mission.

The objective of the HBT is to determine the proper soil moisture content for maximum growth in the microgravity environment of Earth's orbit.

2.2 HISTORY OF EXPERIMENTS

2.2.1 SIR-A

Airborne radar imaging systems have been used for large-scale mapping, particularly in equatorial regions with extensive cloud cover, for many years. It also has been recognized for some time that airborne imaging radars can provide useful ocean wave information, although the exact mechanism by which microwave radar energy is backscattered and modulated to produce ocean wave imagery is still not well understood.

In June 1978, the Seasat-A which carried the first Spaceborne imaging radar system, Synthetic Aperture Radar (SAR), was put into orbit. The Seasat-A SAR was designed to provide 25-m spatial resolution images over a 100-km swath width. The Seasat-A SAR operated at a frequency of 1.37 GHz (23 cm). In this spectral region, the backscatter energy is dependent primarily on the surface physical properties (slope and roughness) and on the complex dielectric constant, which is dependent on surface rock type, moisture, vegetation cover, and near-surface inhomogeneities. The Seasat-A SAR has provided large-scale radar images of land and ocean surfaces for the first time. A preliminary analysis of the data indicates that spaceborne imaging radar will improve our capability to assess earth resources and monitor the ocean surface. It is expected that evaluation of the data from the radar sensor will add new types of information that will complement the geological information presently being collected by optical and infrared sensors and by other conventional mapping techniques. Much more work is needed to understand the geophysical information in the radar signature of different surfaces and to determine the optimum sensor characteristics for

specific applications. The Shuttle Imaging Radar-A (SIR-A) which is scheduled to be flown on the STS-2 is going to address a portion of this research goal.

2.2.2 SMIRR

With the advent of Landsat in 1972 multispectral images have become the primary tool in geologic remote sensing. Research into the use of spectroscopic methods carried out over the last 10 years has shown that the use of narrow spectral bands in the region beyond 1 m can lead to discrimination of important mineralogic constituents of surface materials as opposed to mere discrimination of materials with the use of shorter wavelength information derived from analysis of Landsat data. The U.S Geological Survey has indicated that it may be possible to identify specific clay minerals with narrow-band (0.02 μm) measurements in the 2.2 μm portion of the spectrum. If different clay mineral species can be discriminated using remote sensing techniques, then it may be possible to categorize different types of mineral deposits. Also, different feldspar minerals in unaltered rocks may weather so that different clay minerals are produced which may allow rocks to be better discriminated. To test these concepts, scientists from the JPL and US Geological Survey designed a ten-channel multispectral infrared radio meter to test the value of both broad and narrow spectral bands beyond 1.0 μm for the identification of geologic materials from orbit. Future imaging systems should incorporate such narrow spectral channels if the SMIRR results are positive.

2.2.3 FILE

Remote sensing as a science must account for many variables, some of which are not yet well understood and have not been completely modeled. The observed (by remote sensor) radiance from an Earth feature is a function of the feature's reflectance, the incident illumination level and angle, the radiance and absorption of the atmosphere, and the sensor spectral responses. In addition, the spectral data (feature) classification accuracy ultimately depends upon the classification algorithm chosen.

Earth remote sensing activities of the past have been largely based on collection of data from aircraft and spacecraft over areas of the Earth that contain information of interest, processing of the data in ground facilities, separation of the data of interest from the total collected data, and distribution of the data to the interested users. The time lapse from data sensing to delivery to the user has usually been undesirably long--weeks or months. For some important applications of remotely sensed data, real-time or near-real-time availability of the data is required. Present methods are not only inefficient in terms of waiting time for the user, but also in terms of the volume of discarded data, i.e., data of no interest to the users, such as partially or totally cloud-covered imagery.

The FILE is an experiment designed to test a simple method for doing in-orbit autonomous feature identification and classification, which could provide a tool for greatly improving the efficiency and usefulness of future remote sensing, pointing, tracking, and navigation systems. FILE is based on the principle of spectral radiance (reflectance) ratioing, which has been well developed in ground processing as a useful method of extracting information from spectral data.

2.2.4 MAPS

In 1974, the global distribution of tropospheric CO was summarized using data taken by a number of research groups over a period of several years. The data were obtained at the Earth's surface using ships and at a few altitudes using aircraft platforms. The results indicated that the CO concentration was generally higher in the northern hemisphere than in the southern hemisphere. It was noted that the maritime data was averaged over all seasons and longitudes and did not necessarily represent the continental distribution. The distribution of CO in marine air in the troposphere is given in Figure 2.2.4-1. The thick lines represent the tropopause and the trade wind inversion.

The current MAPS instrument is a space-qualified version of the brassboard system developed for the Nimbus-G program but fabricated as an aircraft test instrument. The instrument from the Nimbus program was used in a continuing flight test program to investigate the utility of

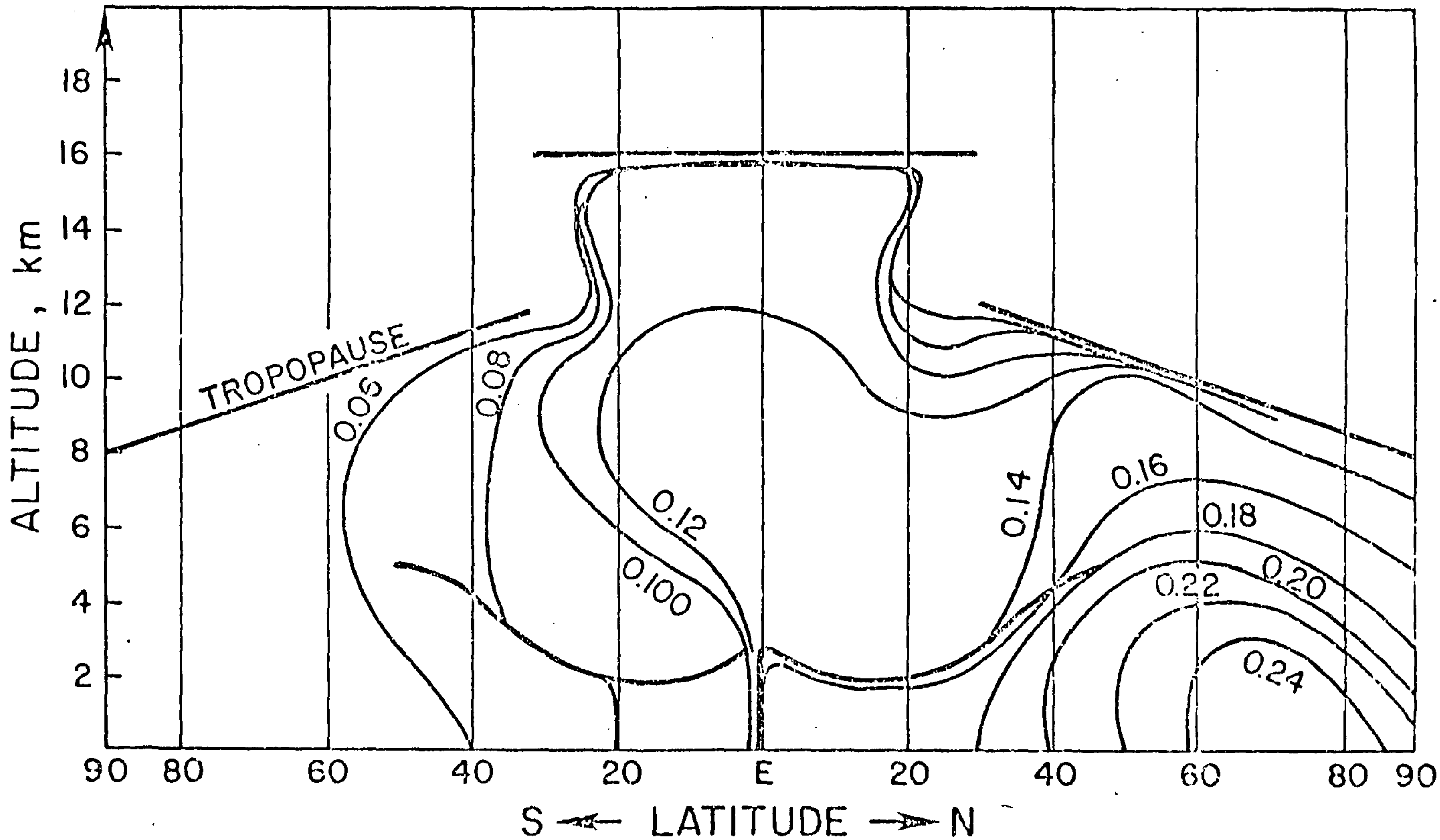


Figure 2.2.4-1. General distribution of CO in marine air in the troposphere. (Seiler, 1974)

aircraft-borne remote sensors for defining urban and regional air pollution problems. The proposed MAPS experiment represents the next step in the logical development of the CO measurement program.

The current gas filter correlation instrument represents a further evolution of a laboratory type nondispersive infrared analyzer, a selective chopper radiometer, a family of gas filter instruments developed under NASA sponsorship, and an instrument developed by the Canadian company, Barringer Research, Inc.

2.2.5 OCE

NASA has built several different ocean color sensors; for example, the Differential Radiometer, the Multispectral Ocean Color Sensor, and the U-2 aircraft-borne Ocean Color Scanner (OCS). These have been tested on aircraft flying at both high and low altitudes. A prototype U-2/OCS was designed and built at Goddard in 1974. Subsequently two more units were built in 1976. The OCE is a modified version of this instrument. Many U-2/OCS flights have been made over inland bays and near-shore waters. An Ocean Color Scanner image taken from a U-2 aircraft 120 n.mi. due east of Jacksonville, Florida, in April, 1980 is shown in Figure 2.2.5-1. The light-colored area on the right side of the computer-processed montage is the warm Gulf Stream. (The speckles are clouds.) On the left is the colder shelf water, which shows up darker because of its high chlorophyll content. The dark filament along the western edge of the Gulf Stream is an upwelling of nutrient-rich (chlorophyll content 1.5 to 2.0 mg/m^3) water from a deeper layer. Such an upwelling, seen here at a very early stage, can develop into a large meander or eddy. Thus, chlorophyll contour images can be used not only to locate high bioproductivity areas in the ocean but also to trace the dynamics of ocean flow.

Currently, a Coastal Zone Color Scanner (CZCS), a variation of the OCS, is being flown on the Nimbus-7 satellite, launched on August 12, 1978. The primary objective of CZCS is to interpret coastal phenomena on the basis of ocean color information.

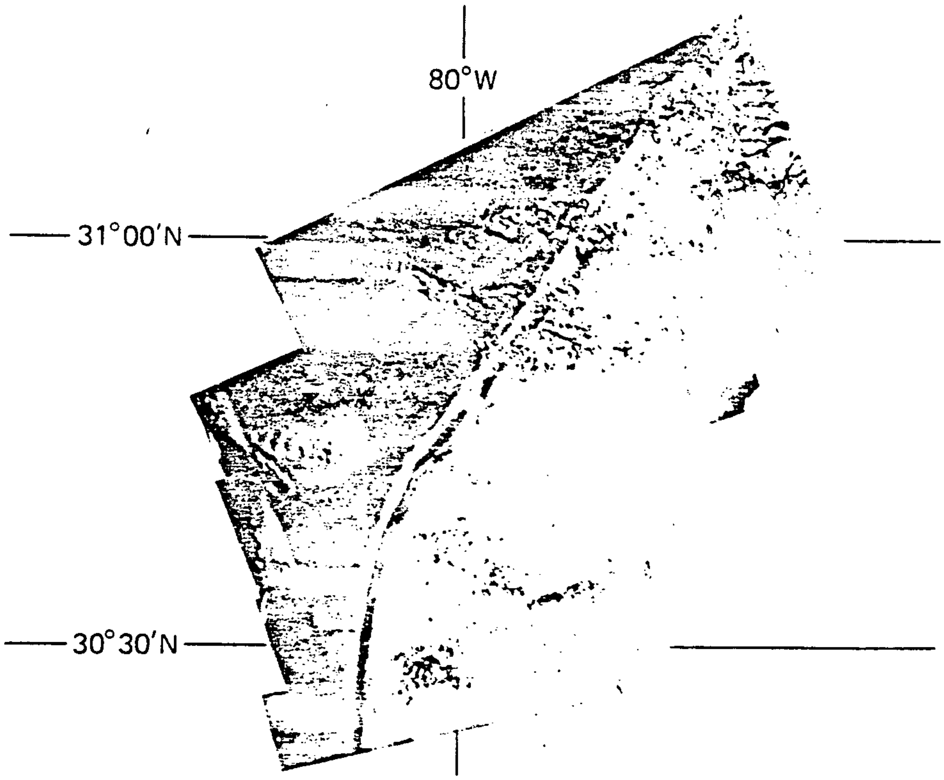


Figure 2.2.5-1. Ocean Color Scanner Images Taken From a U-2 Aircraft

2.2.6 NOSL

Various methods for the detection and recording of lightning strokes have been used by scientists and researchers for many years. The instruments used differ widely according to their function, depending on the particular features of the lightning that are to be studied.

A portable directional lightning recorder was designed for studying individual return strokes by detecting the luminosity of the lightning channel. This principle has been used by other researchers, such as: Brook and Kitagawa (1960), who used a photo-multiplier in conjunction with an electric-field change meter; Krider (1966), using a photodiode at the detector; and Clegg (1971), who used a photocell with associated electronics packages to process the signal. Griffiths and Vonnegut (1975), simplified Clegg's instrument and designed a simple apparatus which consists of a photocell and a tape recorder for detecting and recording characteristics of lightning. A modified cine-sound camera proposed by Vonnegut and Passarelli (1978) can be used not only to photograph thunderstorms but simultaneously to record optical characteristics of lightning events occurring within them. Simultaneous observations of lightning radiations from above and below clouds were studied by Vonnegut and Vaughan (1980). Data was obtained from U-2 overflight during the summer of 1979.

Experience gained from the Gemini, Apollo, Skylab, and Apollo-Soyuz missions indicates that an orbiting platform several hundred kilometers above the Earth affords a view of thunderstorms and lightning that cannot be equaled on the ground or from aircraft. Therefore, it is believed that the orbital flights of the Space Shuttle offer a unique opportunity for obtaining new data on the fine scale circulation of thunderstorms and the electrification processes as induced by lightning. This effort would provide new, invaluable insights into the dynamics of thunderstorms and severe weather.

2.2.7 HBT

Previous experiments by the Russians during the Salyut-4 mission have been reported to indicate that the lack of gravity has two prominent effects on

the growth of plants. First, the water around the roots is redistributed, thereby affecting absorption. Second, the capillary action of the plant roots is enhanced because of the lack of a counteracting g-force. The net effect of these two phenomena, according to the reports, is that plants absorb water more efficiently under microgravity than under normal gravity conditions. Thus, in the microgravity environment of Earth orbit, plants may require less water in their soil for maximum growth.

SECTION 3. EXPERIMENT DESCRIPTIONS

SECTION 3. EXPERIMENT DESCRIPTIONS

A general description of the equipment and the operation of each experiment is presented in this section, along with salient instrument characteristics, calibration required, and accuracies. A summary table of characteristics of all the instruments is given in Table 3.0-1. The location of the experiments on the OSTA-1 pallet is shown in Figure 3.0-1 except for NOSL and HBT which are located in the Orbiter cabin.

3.1 SIR-A

3.1.1 INSTRUMENT DESCRIPTION

The objective of the Shuttle Imaging Radar-A (SIR-A) experiment is to evaluate the potential of spaceborne imaging radars in geologic mapping and to determine the advantages of using radar imagery in conjunction with Landsat imagery for Earth resources observation.

The SIR-A is a synthetic aperture imaging radar which uses the coherent echo from the surface to generate a high resolution image. It uses its own energy to illuminate the surface, and it generates an image from the backscatter echoes. Thus it is not dependent on illumination from the sun. The SIR-A provides an all-weather capability because the relatively long waves (microwave) are not effectively reflected or scattered by, cloud water droplets.

The SIR-A sensor operates at L-band frequencies of 23.5-cm wavelength. The incidence angle at the surface is 50^0 at the center of swath and varies by $\pm 3^0$ at the edges. The sensor is designed to be sensitive to surface backscatter cross-sections between -8 dB and -28 dB. The location of SIR-A on the OSTA-1 pallet is shown in Figure 3.1-1. A schematic figure of SIR-A viewing geometry and signal flow is given in Figure 3.1-2.

The SIR-A data is optically recorded on board the Shuttle. After the Shuttle landing, the signal film is retrieved, developed and processed.

Table 3.0-1 OSTA-1 Instrument Characteristics

Experiment	Characteristics	
SIR-A	Spatial Resolution	38 m
	Swath Width	50.2 km
	Total Surface Coverage	10×10^6 km^2
	Data Acquisition Time	8 hours
SMIRR	Radiometer Spatial Resolution	100 m
	Camera Field of View	18 x 23 km
	Data Acquisition Time	6 hours
	Spectral Resolution	0.06 to 0.1 m half band-width (10 channels)
FILE	Spatial Resolution	1.02 km x 0.75 km
	Field of View	102 km x 75 km
	Spectral Resolution	20 nm
	Total Surface Coverage	5.2×10^7 km^2
	Data Acquisition Time	80-96 hours
MAPS	Spatial Resolution	19 km
	Field of View	19 km
	Global Coverage	3.75×10^7 km^2
	Data Acquisition Time	80-96 hours
	Spectral Resolution	0.05 cm^{-1}
OCE	Spatial Resolution	1-1.7 km
	Swath Width	511 km
	Total Surface Coverage	2.6×10^7 km^2
	Data Acquisition Time	2 hours
	Spectral Resolution	23 nm full bandwidth at half maximum
NOSL	Camera Spatial Resolution	100 ft
	Detector Spatial Resolution	15 nautical miles
	Camera Field of View	$32^o \times 24^o$ at 17 mm focal length $6^o \times 4.5^o$ at 85 mm focal length
	Detector Field of View	$6^o \times 6^o$

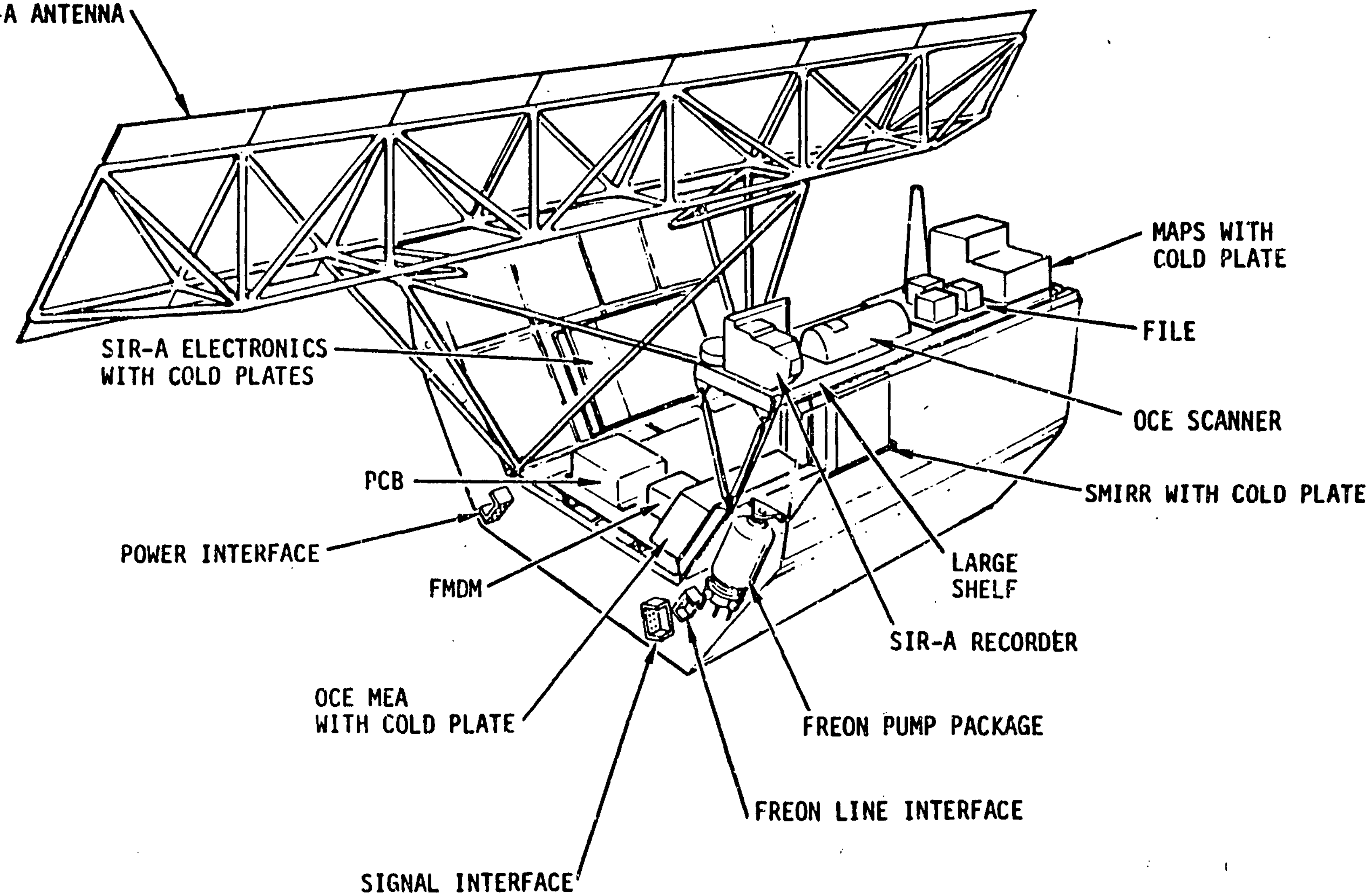


Figure 3.0-1. The OSTA-1 Pallet General Configuration

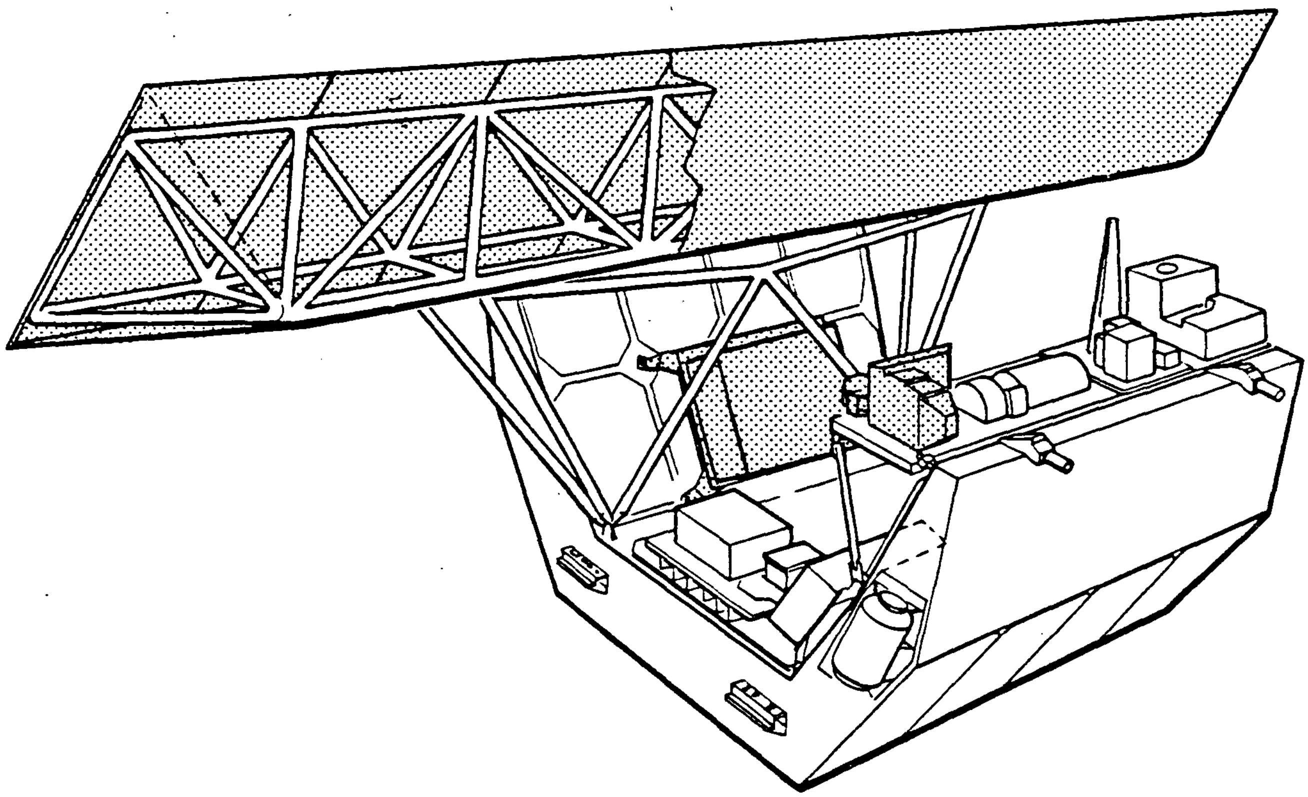


Figure 3.1-1. SIR-A Instrument Location

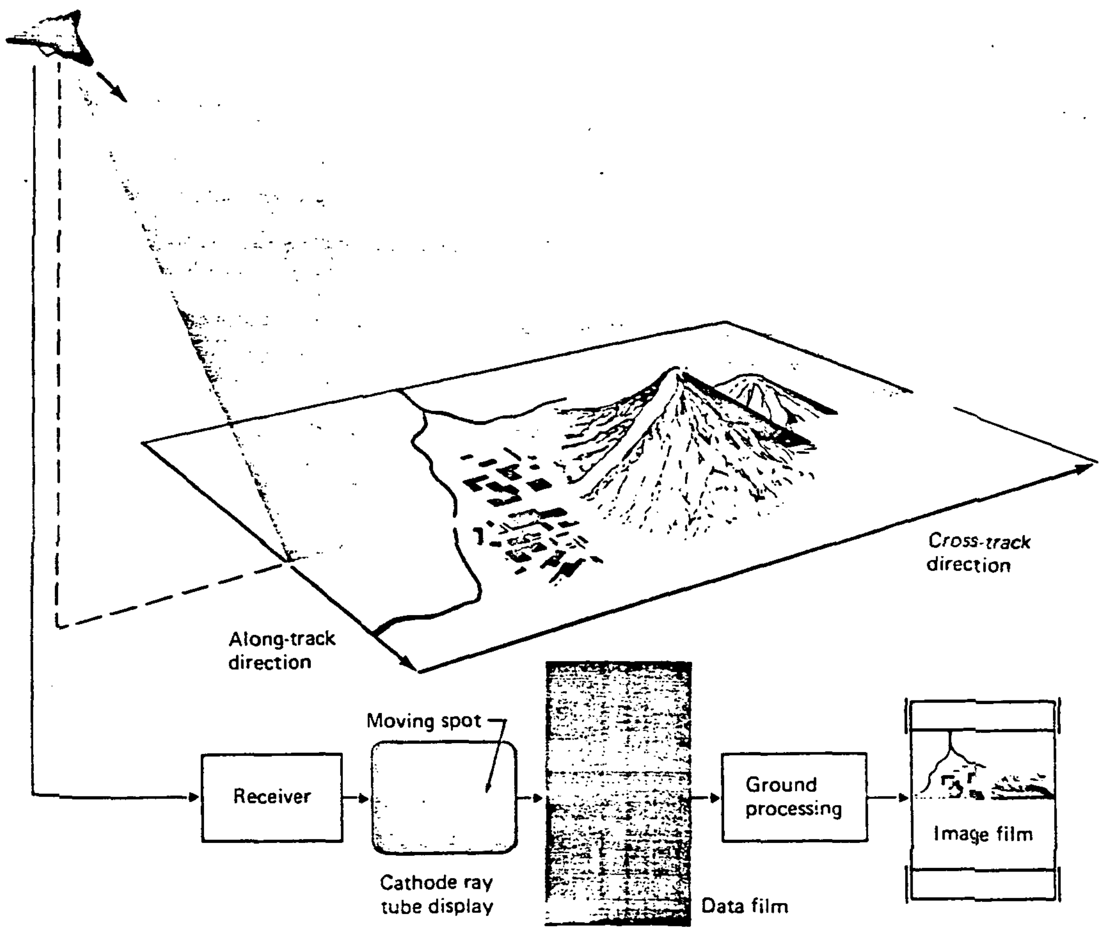


Figure 3.1-2. SIR-A Geometry and Signal Flow Diagram

Then it is converted to an image using an optical correlator. This correlation process is shown schematically in Figure 3.1-3.

3.1.2 INSTRUMENT CHARACTERISTICS

A summary of the SIR-A planned and expected characteristics is given in Table 3.1-1.

Table 3.1-1. SIR-A Characteristics

Characteristics	Value
Frequency (GHz)	1.278
Spatial Resolution (m)	38 x 38
Total Surface Coverage (km^2)	10×10^6
Data Acquisition Time (hrs)	8
Swath Width (km)	50.2
Number of looks (pulses during target visibility interval)	4-7
Peak Power Transmitted (watts)	1000

3.1.3 INSTRUMENT CALIBRATION

3.1.3.1 Preflight Calibration. The SIR-A data collection and processing systems have been designed to be stable with time, that is, the relationship between image reflectance and surface radar cross section will be held constant throughout SIR-A's data. This stability is verified and controlled by using the calibration techniques.

3.1.3.2 Prelaunch Calibration. Prior to film loading, a series of sensitometric wedges will be exposed onto the signal film. After loading, a series of Modulation Transfer Function (MTF) and Automatic Test Function (ATF) square-wave patterns will be exposed by the on-board optical recorder, together with a bias-only reference.

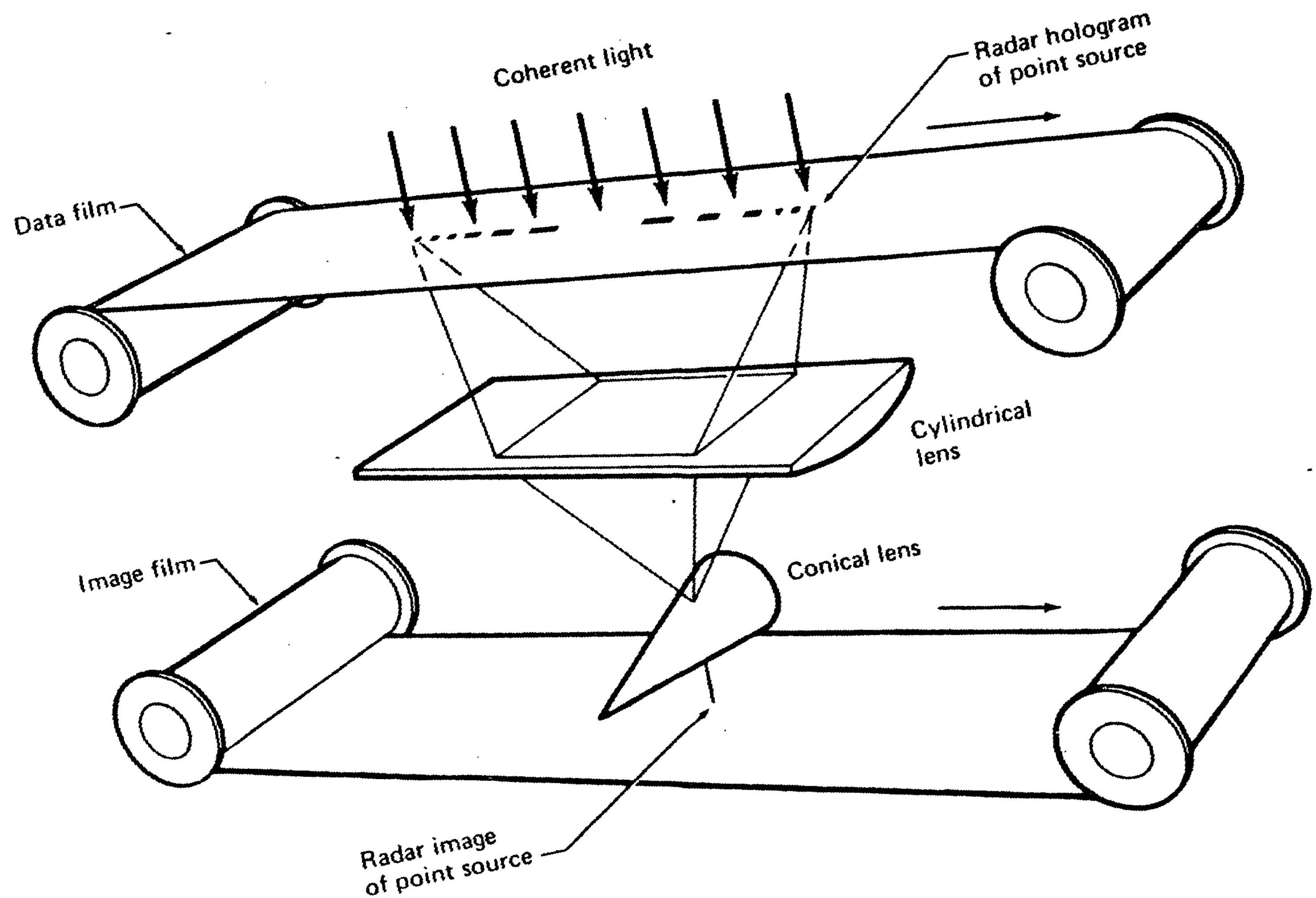


Figure 3.1-3. SIR-A Optical Correlation

3.1.3.3 Inflight Calibration. During flight, a known calibration signal which will always lie within the signal film's dynamic range will be placed on the signal film at the beginning of each data take. A smaller number of calibration signals which will lie within the image film's dynamic range after correction will also be used.

3.1.3.4 Postflight Calibration. Information obtained during the pre-launch calibration will be used to monitor the development and correlation process after the flight.

3.1.4 ACCURACY

3.1.4.1 Instrument Accuracy. The range resolution will nominally be 38 meters. However unfavorable pointing errors at the equator can degrade the range resolution at the swath edges up to 60 meters with 38 meter resolution still occuring over the center 25 km of the swath.

In general, 38 meter azimuth resolution will be maintained with between 6 and 7 azimuth looks. In cases where unfavorable pointing errors or optical recorder film drive jitter occur, 38 meter resolution can be maintained but the number of looks may drop to 4 or 5.

3.1.4.2 Geometric Accuracy. The azimuth scale factor of 500,000:1 will be maintained to within at least 1%. For selected processing runs, using orbital information, an accuracy of at least 0.1% can be achieved.

Range scale factor will nominally be 500,000:1 at the center swath. Since the presentation is in slant range, however, the near range scale factor will be about 515,000:1 and the far range factor about 485,000:1 with an approximately linear variation in between. During the mission the incidence angle can change by as much as ±1.5 degrees. In the initial survey processing this variation will not be corrected, and the resulting imagery will not always have a 500,000:1 range scale factor at swath center. This unity aspect ratio point will occur anywhere within about ±20 km of swath center. The near range and far range scale factors can thus vary about ±2% of the values stated above.

Data skew will in general be present in the image. A square on the ground oriented parallel to swath direction will be changed to a parallelogram in the image. Range lines perpendicular to the swath direction will be imaged at an angle approximately equivalent to the Doppler angle being processed. This skew, which can be as high as 3 or 4 degrees, can be mostly removed for selected processing runs.

3.1.4.3 Radiometric Accuracy. Within a given 50-km square the relative radiometric accuracy should be about 1 dB. Over long distances and from pass to pass the relative accuracy is more likely about 3 dB.

3.2 SMIRR

3.2.1 INSTRUMENT DESCRIPTION

The location of SMIRR on the OSTA-1 pallet is shown in Figure 3.2-1. The SMIRR instrument is shown in Figure 3.2-2. It consists of a Cassegrain telescope, a spinning filter wheel containing 10 interference filters followed by two mercury-cadmium-telluride detectors that are thermoelectrically cooled. Since SMIRR is not an imaging instrument, precise location of the instantaneous field of view (IFOV) on the Earth's surface is necessary. Two 16-mm framing cameras with reseau plates are aligned with the telescope and provide location information. A SMIRR block diagram is shown in Figure 3.2-3.

3.2.2 INSTRUMENT CHARACTERISTICS

SMIRR characteristics are:

Optics:	19 cm (7½ in.) diameter Cassegrain (MVM '73) spare
Filters:	ten: six 0.1 μm BW, one 0.06 μm BW, three 0.02 μm BW, centered from 0.45-2.35 μm
Detectors:	two HgCdTe, thermoelectrically cooled to 192°K
IFOV:	450 μrad; equivalent to 115-m diameter spot on ground
Encoding:	12 bits
Location:	two boresighted 16-mm framing cameras covering 20-km swath in B/W and color
Recording:	approx. 6 hours on Shuttle Orbiter payload recorder
Operation:	manual or with sequencer
Camera FOV:	18 x 23 km

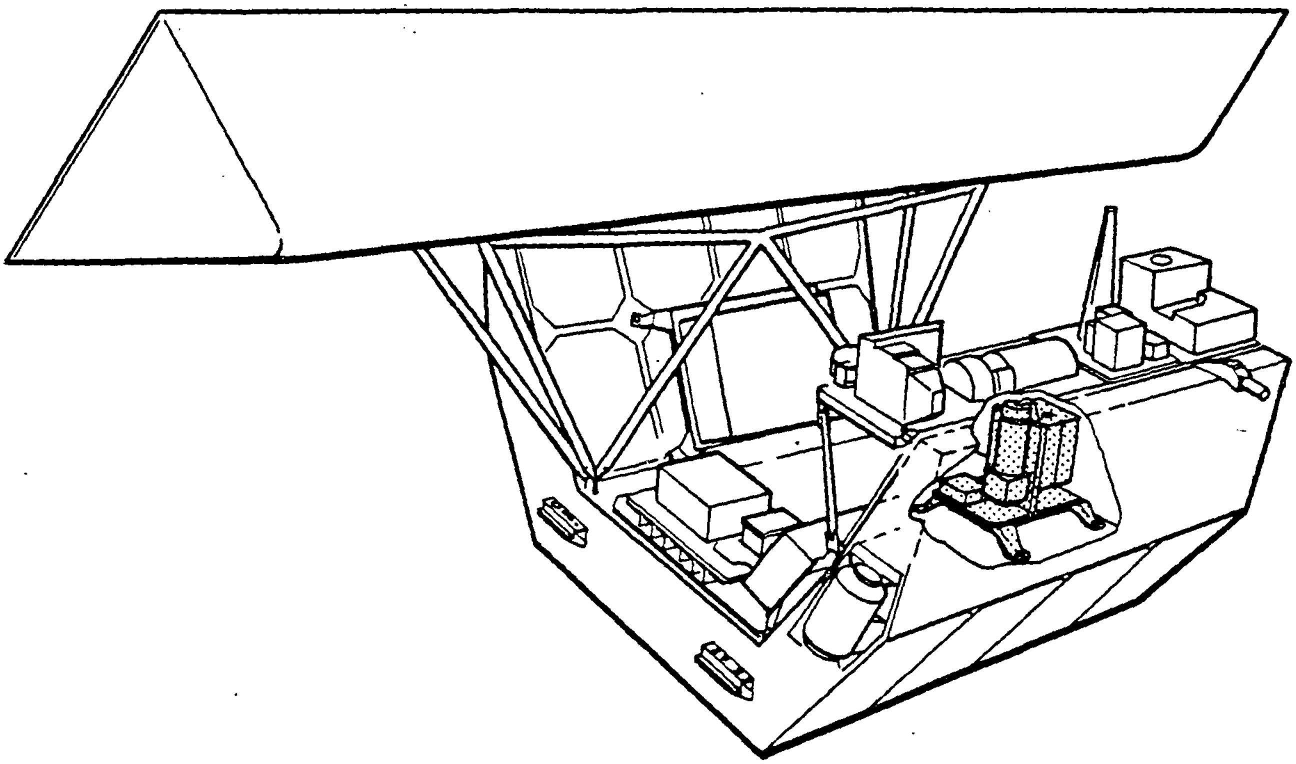


Figure 3.2-1. SMIRR Instrument Location

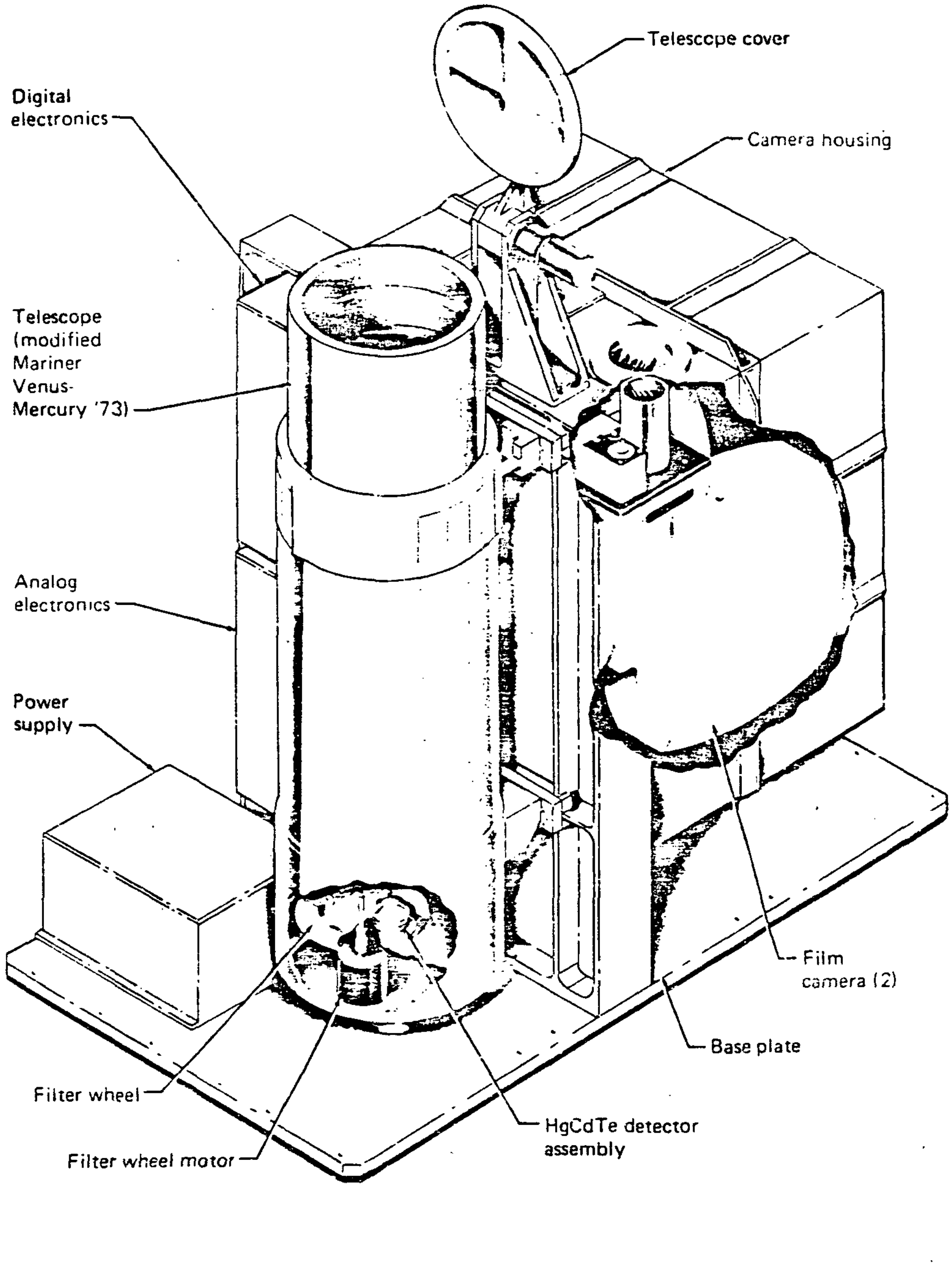


Figure 3.2-2. SMIRR Instrument

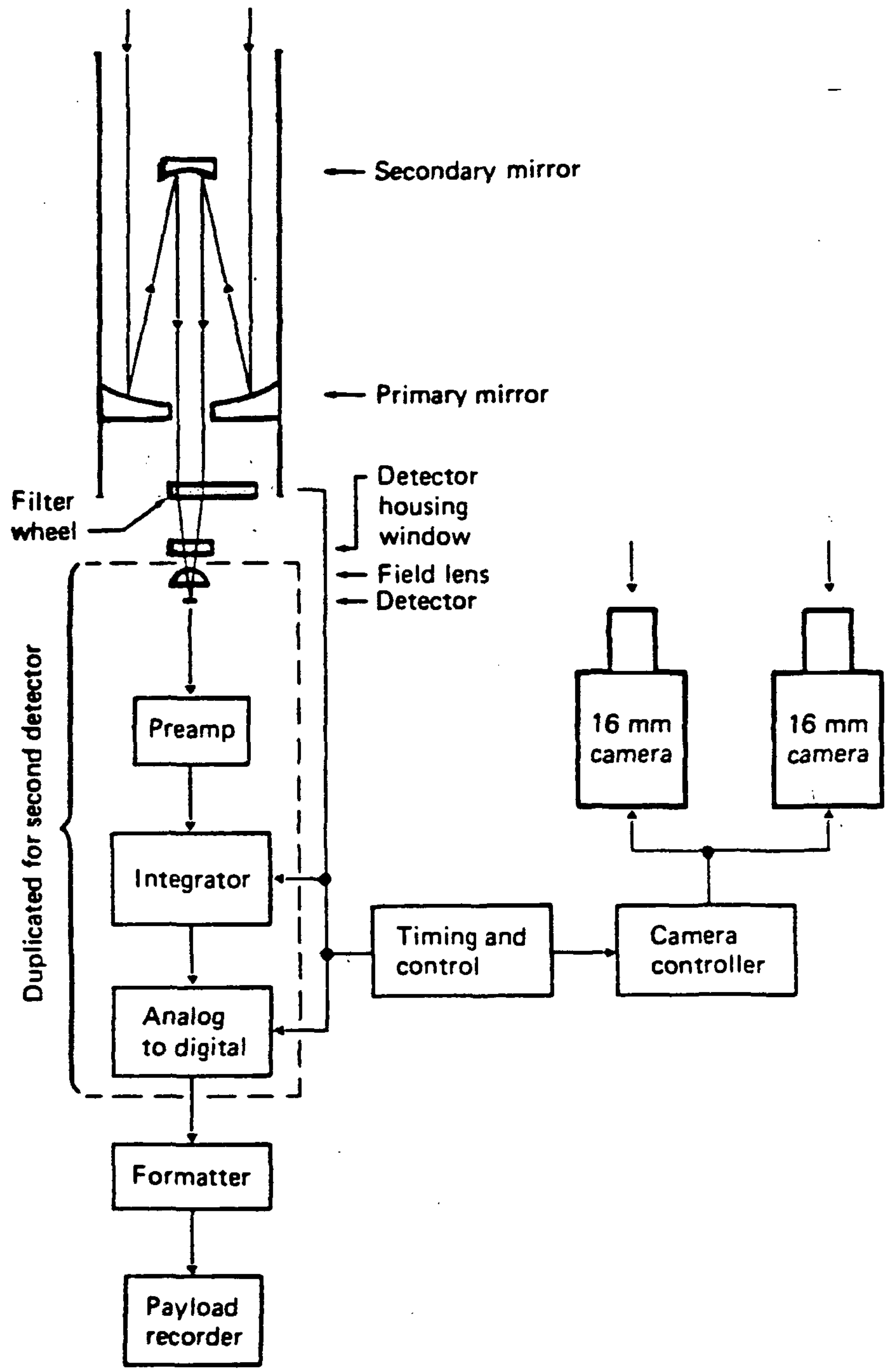


Figure 3.2-3. Simplified SMIRR Block Diagram

3.2.2.1 Spatial Coverage

a. Radiometer IFOV. The radiometer instantaneous field of view (IFOV) is determined by the telescope focal length, field stop, field lens, and detector dimensions. The major variable in the system is the accuracy of the field lens placement in the detector package. Differences in the placement of the two field lenses result in slightly different IFOV's for the two detectors.

The IFOV of each detector was scanned by a point source at the focal plane of the Fairchild 4040-mm collimator at JPL. The size of the IFOV of each detector was determined by mapping these data and measuring the location of the half-power points. The "A" detector IFOV is 473 x 434 microradians (132 x 121 meters), along track versus cross-track dimensions, assuming a 280 kilometer orbit.

b. Movie Cameras. The movie camera field of view is a function of the film format size and camera lens focal length. Each camera's field of view is 18 x 23 km, along track versus cross-track dimensions, assuming a 254 km (137 n.mi.)orbit.

3.2.2.2 Spectral Resolution and Coverage

a. Radiometer. The radiometer contains ten discrete interference filters. The central wavelength, half-band width, and peak transmission of each filter are listed in Table 3.2-1.

b. Movie Cameras. Each movie camera has a commercially-purchased filter to reduce atmospheric haze in the film image. The color camera has a #2E filter and the black-and-white camera uses a #8 (yellow) filter.

Table 3.2-1. Filter Spectral Characteristics

Central Wavelength (Microns)	Half-bandwidth (Microns)	Peak Transmission (Per Cent)
0.50	0.10	59.6
0.60	0.10	64.0
1.05	0.10	51.0
1.20	0.10	58.2
1.60	0.10	52.8
2.10	0.10	74.2
2.17	0.02	66.0
2.20	0.02	71.8
2.22	0.02	60.8
2.35	0.06	59.5

3.2.3 INSTRUMENT CALIBRATION

3.2.3.1 Preflight Calibration

a. Light Cannon. The response of SMIRR over the range of light levels expected in flight is measured with a light cannon. The light cannon is a radiometrically calibrated light source that can be varied in intensity without changing its color temperature. It consists of quartz iodide lamps, an integrating hemisphere, an iris to vary the intensity, and a ground-quartz diffuser. The light cannon was spectrally calibrated at Johnson Space Center with an EG&G spectroradiometer. The relative spectral data is presented in Figure 3.2-4. Data at wavelengths longer than 2.5 μm have been extrapolated. The iris was calibrated using a cross-polarized variable transmittance standard and a Gamma 700 photometer at JPL. These results were compared to a National Bureau of Standards secondary 100-foot-lambert source before and after each instrument calibration to select the proper light levels for the calibration.

b. Instrument Calibration. Each instrument calibration consists of data taken with the cover closed and internal calibration lamps off,

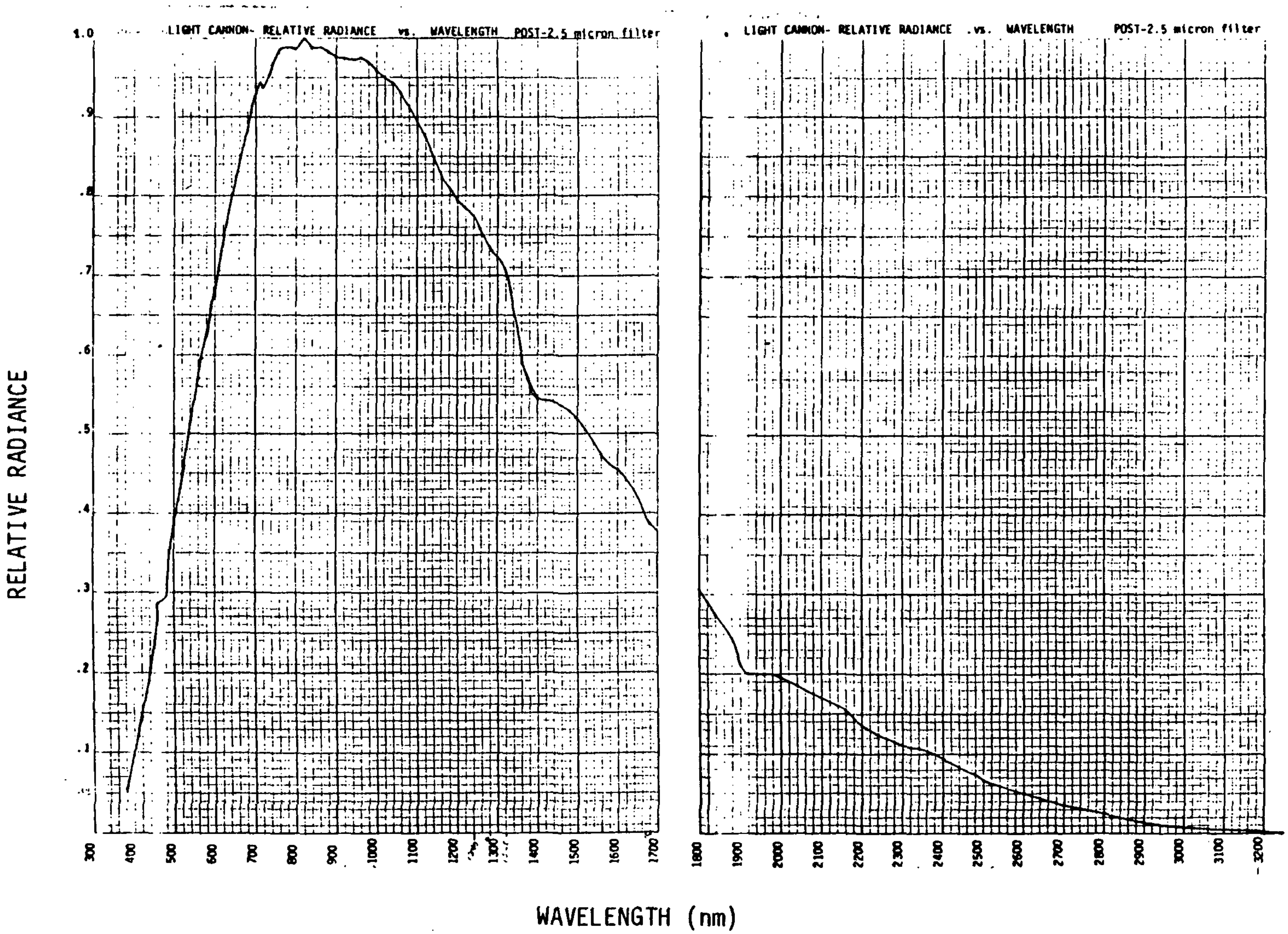


Figure 3.2-4. SMIRR Radiance vs. Wavelength

with the cover closed and internal calibration lamps on, and with the light cannon at fifteen light levels between 30 and 3000 foot-lamberts. The data were recorded on a digital tape in the GSE and then values of DN and the corresponding radiance (watts/cm^2 at the telescope entrance aperture) were plotted for each filter. These "light transfer curves" are the basic tool for decalibrating the flight data. Typical light transfer curves for the 1.2 μm filter and detector A are given in Figure 3.2-5.

3.2.3.2 Prelaunch Calibration. Every two months a calibration verification is run using the internal calibration lamps to monitor the health of the detectors.

3.2.3.3 Inflight Calibrations. Prior to every data-taking period, the internal calibration lamps are observed. These data will be used to adjust the instrument calibration data for any changes that have occurred since the last calibration.

3.2.3.4 Post Flight Calibration. A full calibration procedure using the light cannon and the internal lamps will be performed at JPL after return of the instrument.

3.2.4 ACCURACY

The desired absolute accuracy for SMIRR is $\pm$10%. However, the desired relative accuracy for SMIRR is $\pm$5%.

3.3 FILE

3.3.1 INSTRUMENT DESCRIPTION

FILE is based on the fact that the Earth's surface cover, namely water, bare land, vegetation, and clouds/snow/ice can be identified by ratioing two spectral channels of reflected solar radiation in bands located at 0.65 μm and 0.85 μm. The ratio of the reflected solar radiations at these two wavelengths is relatively independent of such factors as solar illumination angle and atmospheric effects, and these two channels do not include any major atmospheric absorption (radiation) bands. Figure 3.3-1

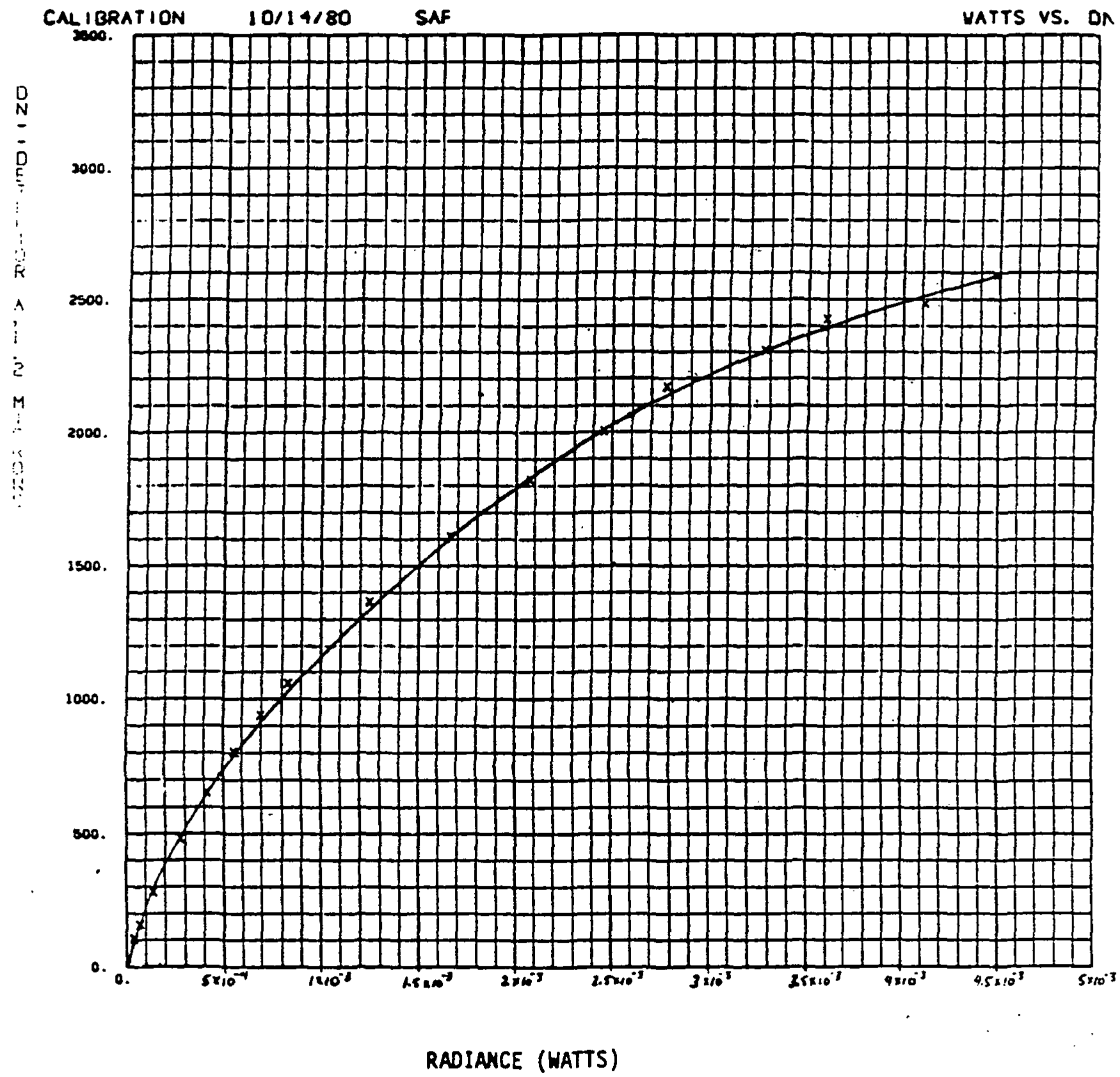


Figure 3.2-5. SMIRR Light Transfer Curve

shows the approximate feature separability to be expected from the FILE radiance measurements.

The two FILE sensors are bore-sighted charge-coupled device (CCD) cameras (100 x 100 arrays). Instrument characteristics are summarized in Section 3.3.2. The FILE system consists, in addition to the two CCD sensors, of a decision-making electronics unit which does the real-time feature classification, a tape recorder, a tape recorder storage buffer, a 70-mm camera and a sunrise sensor to provide operation of the instrument only on the daylight side of the Earth. The decision-making circuitry is shown in Figure 3.3-2, and the hardware arrangement in Figure 3.3-3. The FILE equipment is mounted on the OSTA-1 pallet experiment shelf, as shown in Figure 3.3-4. About 120 frames of data will be sent via the temporary buffer storage to the FILE tape recorder during the mission. Data recorded for each frame include digitized images from the two CCD cameras, a count of the total number of pixels in each scene that were classified into each feature category, and the date and time of day to allow post-flight determination of latitude and longitude. To provide auxiliary ground-truth data, the FILE experiment also includes a 70-mm color-film camera, bore-sighted with the CCD cameras, to record an image each time a CCD image is read into the buffer.

To increase the variety of data returned, the instrument counts the number of frames of data representing scenes that are predominantly water and clouds or bare land. It will not record data for scenes in either of these classes after a quota of 31 frames has been taken.

The FILE power supply receives +28-volt direct-current primary power from the Shuttle. A FILE timer controls the timing of data taking. Dectection of sunrise by the sunrise sensor initializes the timer (see Figure 3.3.-5), and the timer activates the power supply and buffer memory unit for data taking at a pre-determined timing interval, starting at a set time after sunrise detection. At the completion of the CCD sensor raster scans, for a given data take, the buffer memory unit is commanded to transfer its data to the recorder, and the film camera shutter is activated. This action can be inhibited by the scene processor, on the basis of the scene analysis. A format timer generates scan timing for the CCD sensors and formats all data transferred to the buffer memory unit. The format timer also demodulates

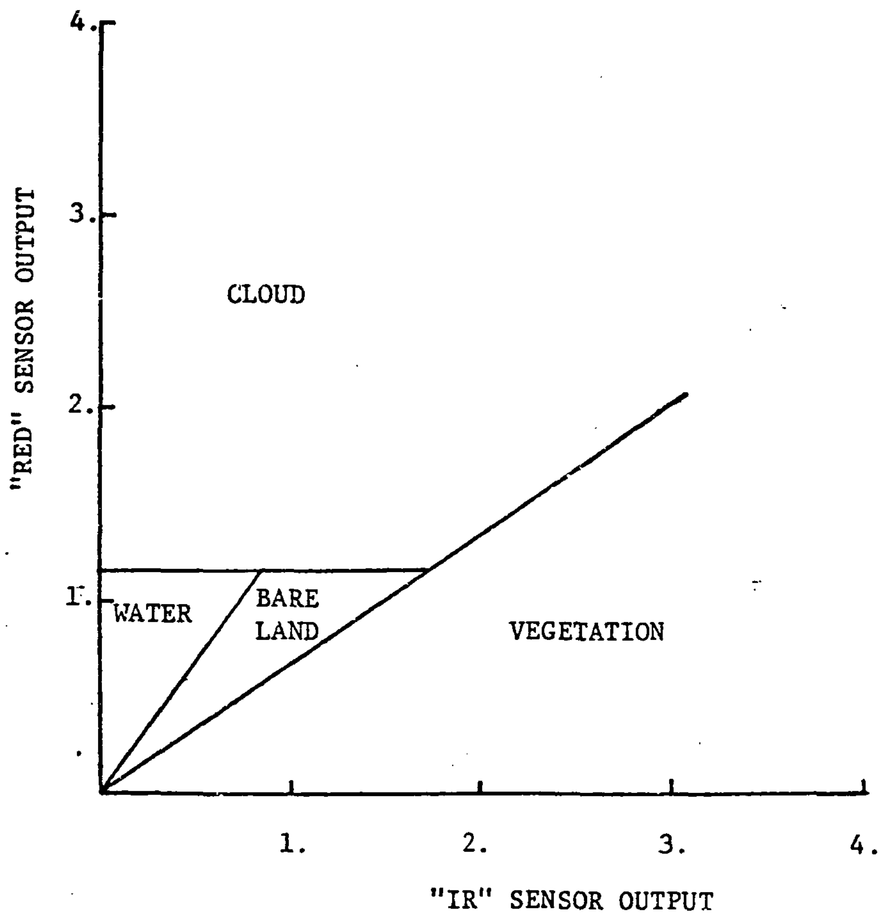


Figure 3.3-1. Feature Separability for FILE Experiment.

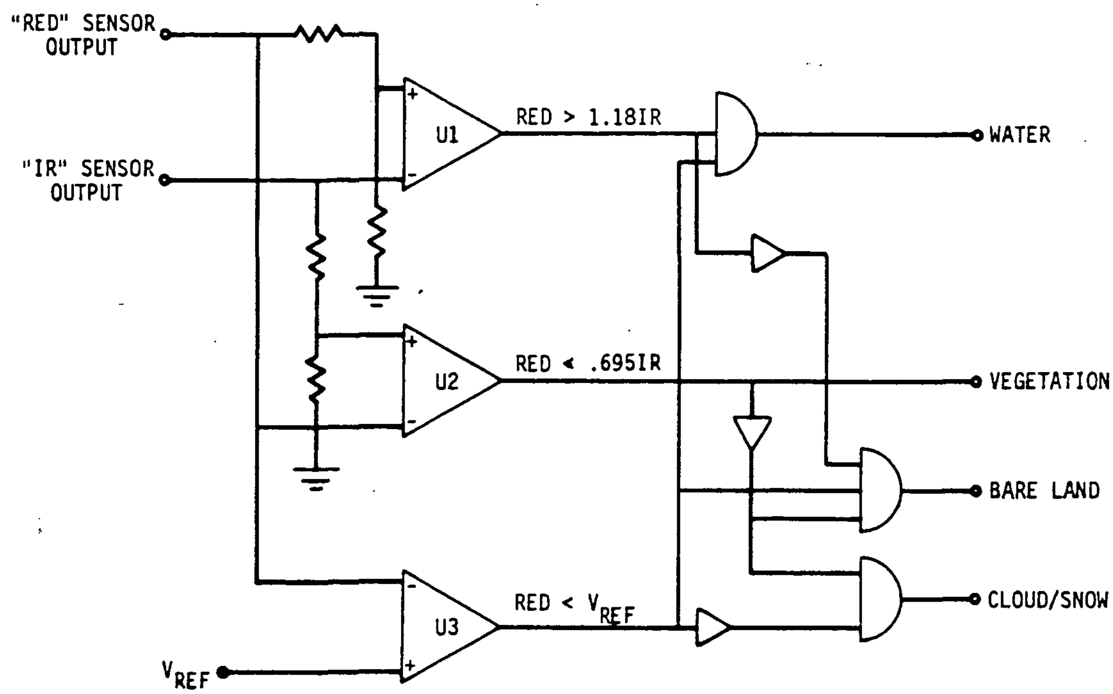


Figure 3.3-2. Simplified Decision Circuitry of FILE.

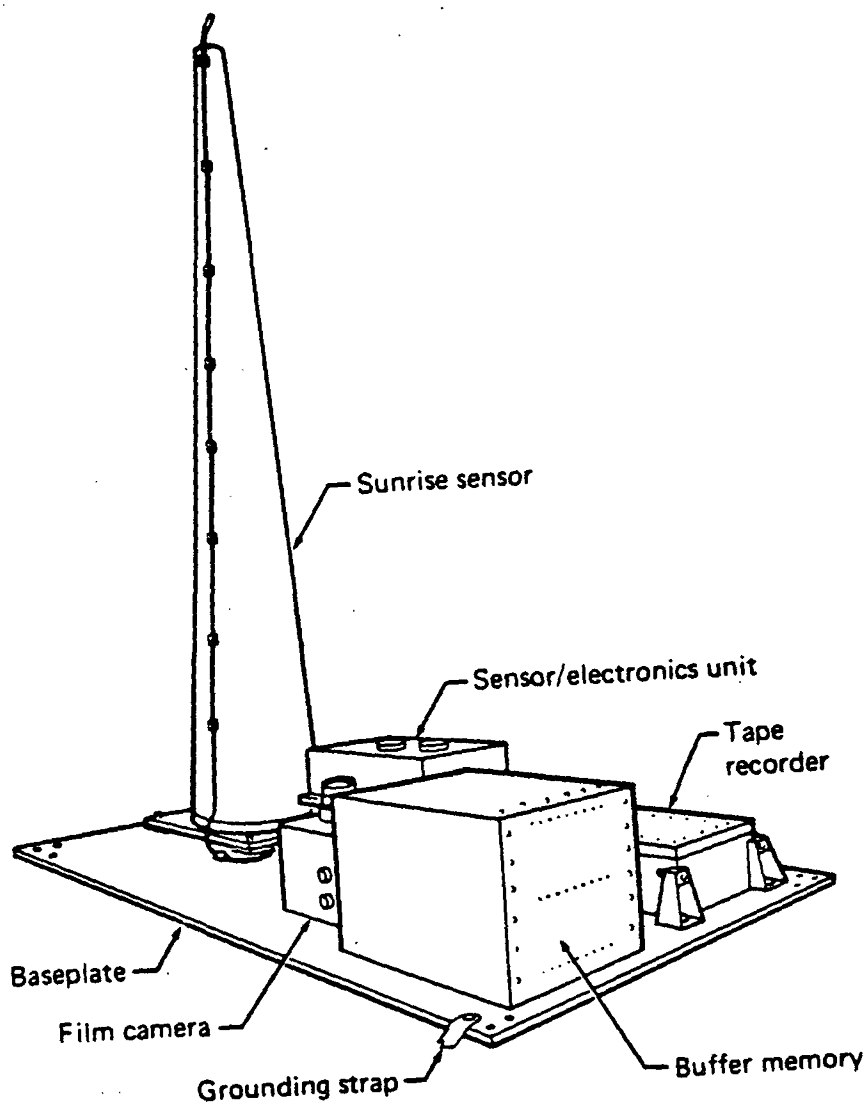


Figure 3.3-3. The FILE Experiment Configuration.

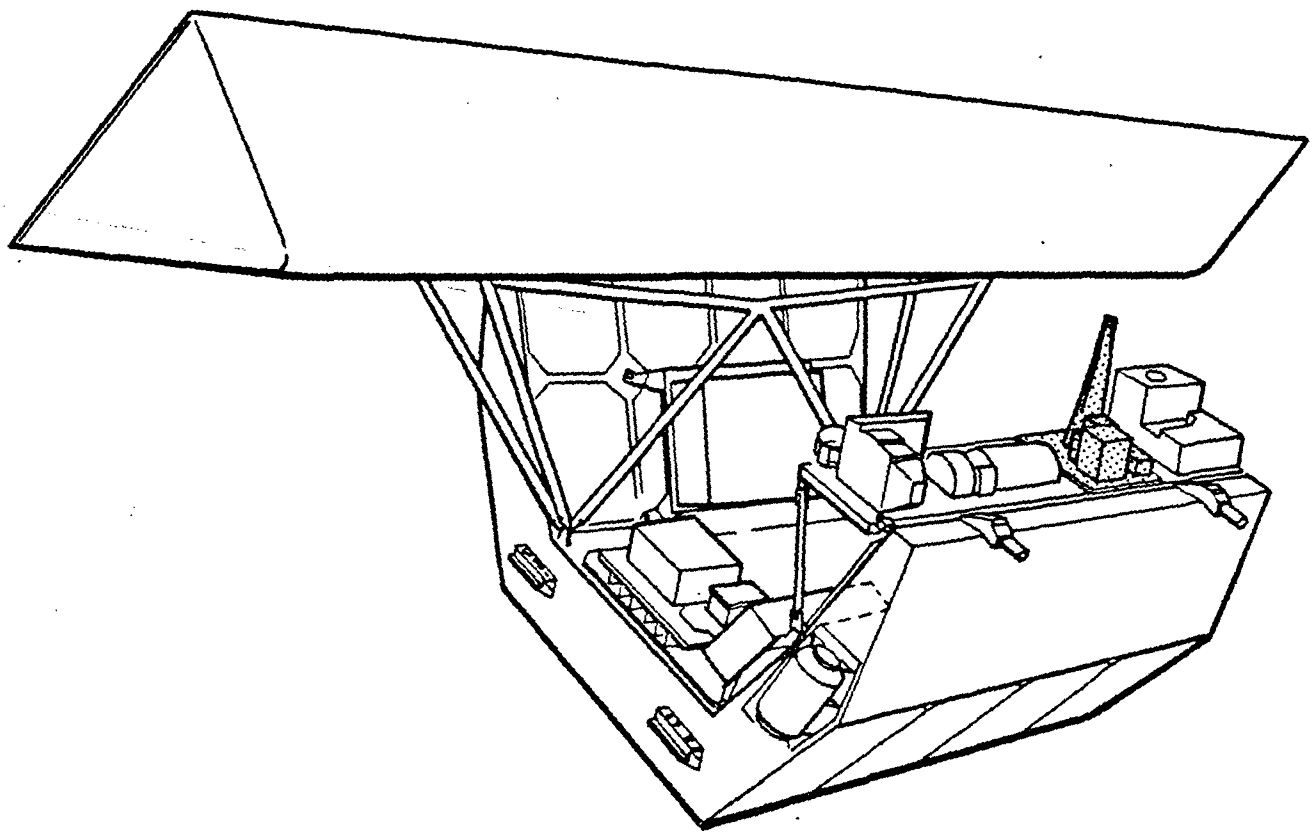


Figure 3.3-4. FILE Instrument Location

the Shuttle Greenwich mean time (GMT) data stream for insertion into the data format. The scene processor performs two major fuctions: 1) it digitizes the CCD signals for incorporation into the data format, and 2) it classifies the image into the four basic feature categories, as discussed earlier. Classification is based on sensor amplitude and ratio. The number of pixel elements classified into each feature category is accumulated and incorporated into the data format.

The temperature controller operates on the primary + 28 volts and turns on heater resistors when (if) the temperature falls below + 13^{o}C. The heater control is independent of the FILE timer controls.

3.3.2 INSTRUMENT CHARACTERISTICS

Field of View :	102 km x 75 km
Spatial Resolution :	1.02 km x 0.75 km
Spectral Resolution :	.65 μm, 20 nm. bandwidth .85 μm, 20 nm. bandwidth
Total Surface Coverage:	0.8×10^6 km^2
Data Acquisition Time :	80 - 96 hours depending on Shuttle maneuvers
Camera Field of View :	142 km

3.3.3 INSTRUMENT CALIBRATION

Prior to flight, sensors are boresighted to ± 0.05 degrees and then are calibrated for response before installation on the pallet. The FILE CCD cameras were calibrated in November, 1980. The calibration was done by comparing the outputs of the cameras with the output of a radiometer (silicon detector) while the cameras and radiometer were viewing the same uniformly lighted white target. The target was illuminated with a quartz iodide floodlamp. The radiometer spectral response was matched to the response of each camera by using matching spectral filters. Before the camera calibrations, the radiometer was calibrated, with each filter, by using a secondary lamp whose calibration is traceable to the C.N.R.C. calibrated lamp. The dominant error sources were the pixel-to-pixel

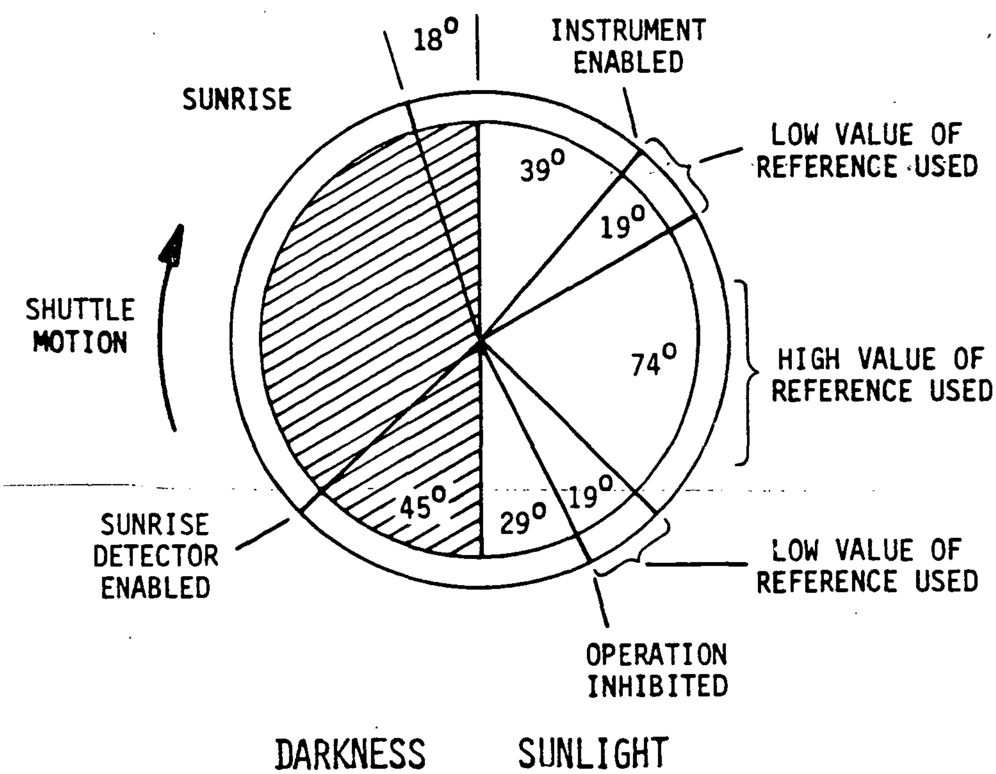


Figure 3.3-5. Orbit Timing as a Function of Time Since Sunrise.

response nonuniformity of the cameras themselves and nonuniformity of illumination of the target for the cameras.

After the flight, preflight calibration will be repeated.

3.3.4 ACCURACY

The geometric accuracy and radiometric accuracy are explained in Section 3.3.3. Calibration accuracy is approximately 16%.

3.4 MAPS

3.4.1 INSTRUMENT DESCRIPTION

The MAPS instrument consists of an electro-optical head, an electronics module, a digital tape recorder, and a camera. The 80-kg MAPS package is 90 cm long, 76 cm wide, and 58 cm high. The equipment is coupled to a cold plate and mounted on the experiment pallet shelf. The electro-optical head contains two gas cells, one at 266 torr CO, the other at 76 torr CO; their corresponding detectors; a direct radiation detector; an external balance and gain check system; and an internal balance system. The electronics module consists of the signal processors, the balance system controls, and the circuits needed to operate the system. The Lockheed Mark V digital tape recorder records data at 50 bits per second. The aerial camera, equipped with a light sensor, will photograph the ground track during sunlit portions of the orbit. Figure 3.4-1 depicts the MAPS instrument in operation.

The core of the MAPS instrument is a gas filter correlation radiometer. Thermal radiation passes up through the atmosphere into the viewport of the downlooking instrument. The carbon monoxide in the air produces unique absorption lines in the transmitted energy. A beam of the incident radiation passes through the high pressure CO gas cell and onto a detector. This high pressure CO gas cell acts as a filter for the effects of CO present at low altitudes. A second beam falls directly onto a detector without passing through any gas filter. The difference in the voltage of the signals from these two detectors can be used to determine the amount of carbon monoxide present in the atmosphere at an altitude of 7-8 km. A

third beam of the incident radiation passes through the low pressure CO gas cell and onto a detector. The low pressure CO gas cell filters out the effects of CO present at high altitudes. The difference in voltage from this and the direct detector provides a measure of CO concentration at an altitude of 10-12 km. Figure 3.4-2 illustrates this operation.

The instrument is contained within an enclosure designed to attenuate the Shuttle acoustical vibrational, and thermal environments. An aluminum box-shaped cover completes the package. For thermal protection, the enclosure is wrapped with multilayer aluminized Mylar film.

The MAPS equipment is attached to a single base plate located in the Shuttle bay. This method of mechanical attachment simplifies the instrument integration and testing and permits the use of standardized interface equipment. The location of the instrument on the OSTA-1 pallet in shown in Figure 3.4-3.

Thermal control requirements are satisfied for the MAPS components by thermal coupling to the mounting plate. The experiment is thermally isolated from the radiative environment by a multilayer-insulation thermal blanket. Thermal control is maintained through the Shuttle pallet freon cooling loop and a cold plate thermally coupled to the MAPS mounting plate.

When the Space Shuttle has attained its Earth-viewing position, pallet power will be supplied and the MAPS instrument turned on. After a 30-minute warmup, the instrument is balanced and its gain is checked before it begins to take data. Data-taking continues throughout the Earth-observing period, with balance and gain check recurring at 12-hour intervals or upon request sent from the Principal Investigator. The three instrument outputs (two difference signals and one radiometer signal) are digitized, formatted, and stored on the experiment's tape recorder. The aerial camera mounted alongside the MAPS electro-optical head will provide information on cloud cover and the terrain over which the data are gathered.

3.4.2 INSTRUMENT CHARACTERISTICS

Spatial Resolution = 19 km
Spectral Resolution = 0.05 cm^{-1}

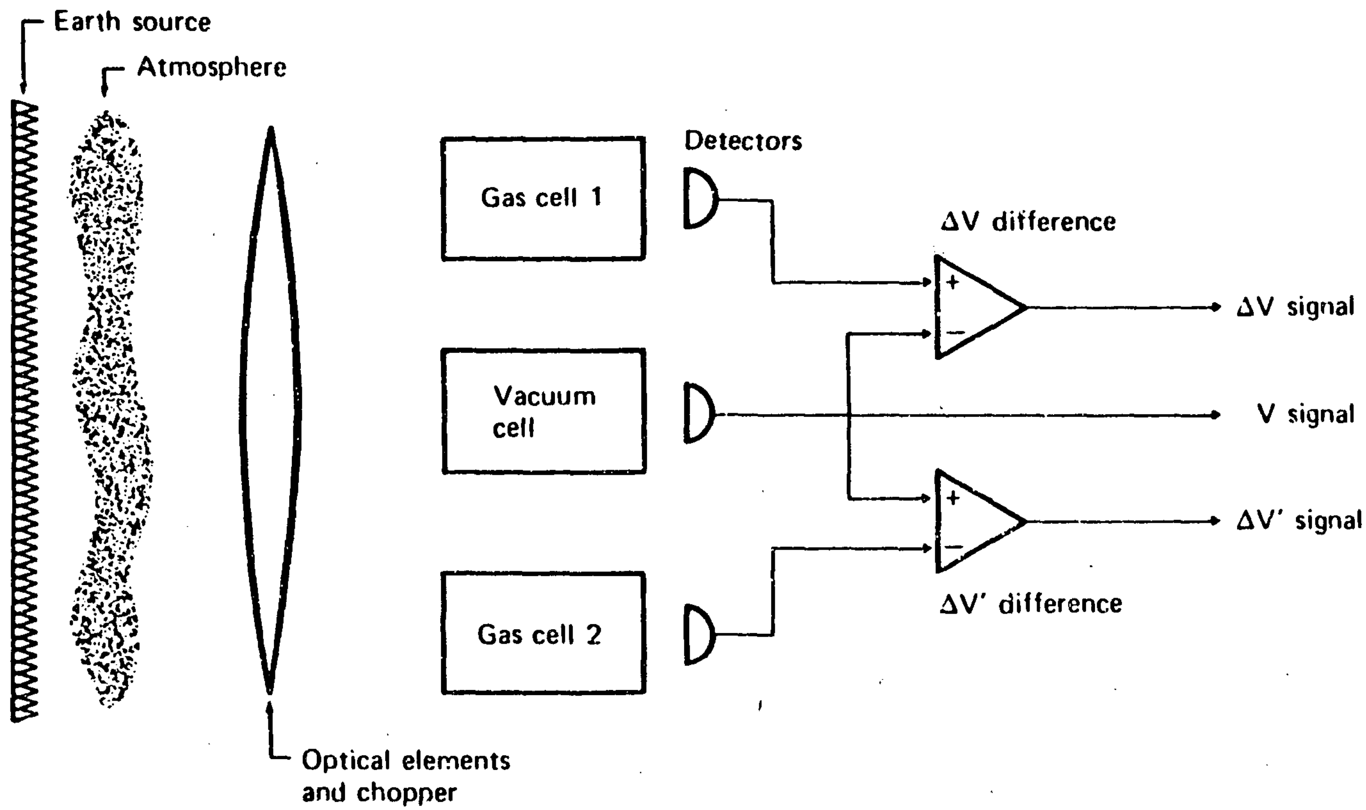


Figure 3.4-2. MAPS Instrument Operation

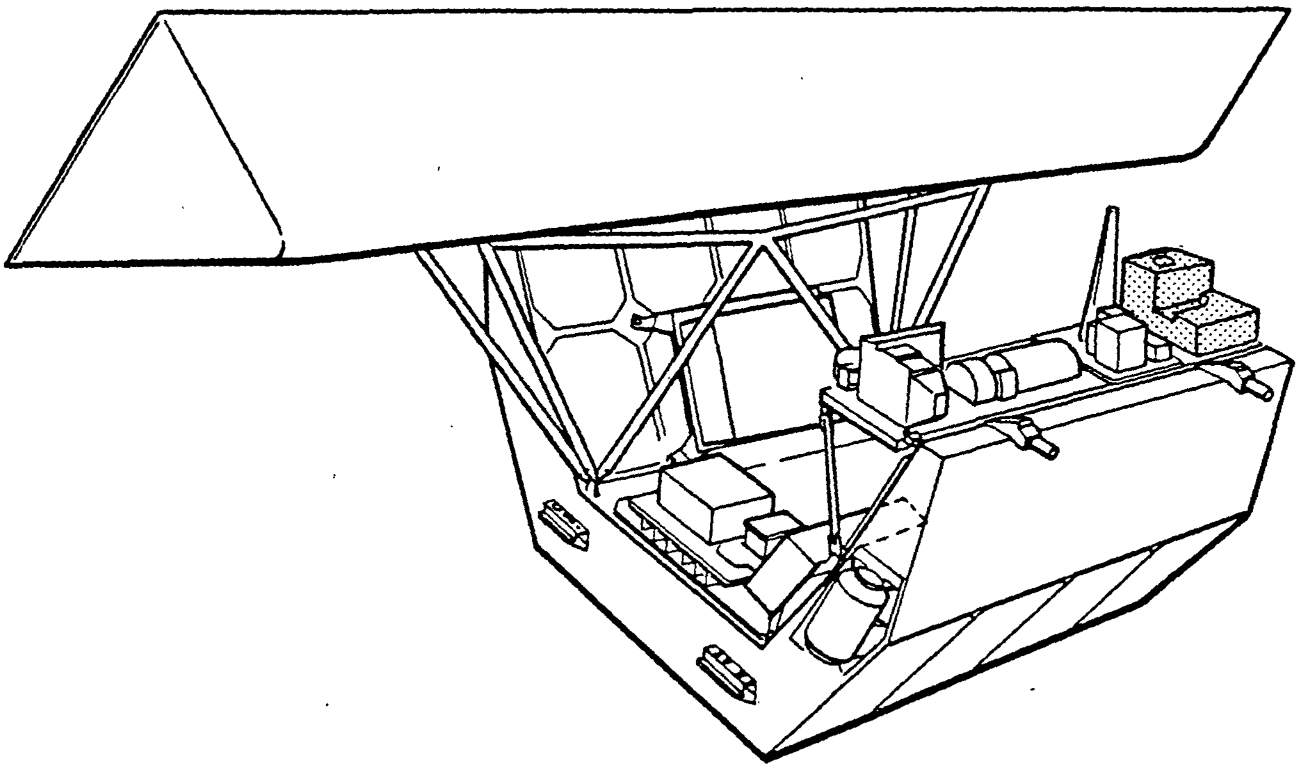


Figure 3.4-3. Location of the MAPS Instrument on the OSTA-1 Pallet

Global Coverage = 3.75×10^7 km^2
Data Acquisition Time = 80-96 hours depending on Shuttle maneuvers

3.4.3 INSTRUMENT CALIBRATION

3.4.3.1 Preflight Calibration. The preflight calibration will occur at Langley Research Center using the dedicated MAPS calibration variable temperature gas cell, a high quality variable temperature blackbody radiation source, and the associated filling, control, and measurement equipment. This unit serves as the radiometric standard for the MAPS instrument and provides a capability for simulating a broad range of source temperatures and gas concentrations. The source and cell operate at variable, controlled temperatures. When used with the test set, it provides the capability for a complete end-to-end checkout and calibration of the MAPS instrument.

The instrument is internally balanced so as to be relatively insensitive to changes in background temperature. Two blackbodies, one at the hot end of the expected temperature range, the other at the cold end, are introduced one at a time into the optical path with no gas between them and the instrument. The gain of each gas cell detector is adjusted so that each blackbody registers the same voltage, thus providing a baseline for signal measurement.

A similar system located externally serves to check both the balance set by the internal system and the instrument's gain stability. A pointer mirror rotates from a hot blackbody, to a cold blackbody, to a normalizing source, and finally to the viewport. Figure 3.4-4 shows the MAPS instrument calibration scheme.

The instrument was first calibrated during August, 1979 before the level IV integration and later after integration. In September, 1980, following storage at Langley, it was recalibrated. The two calibrations agreed closely, but with a slight decrease in responsivity and a slight increase in noise. As of September, 1980, the instrument was performing well within acceptable limits of operation.

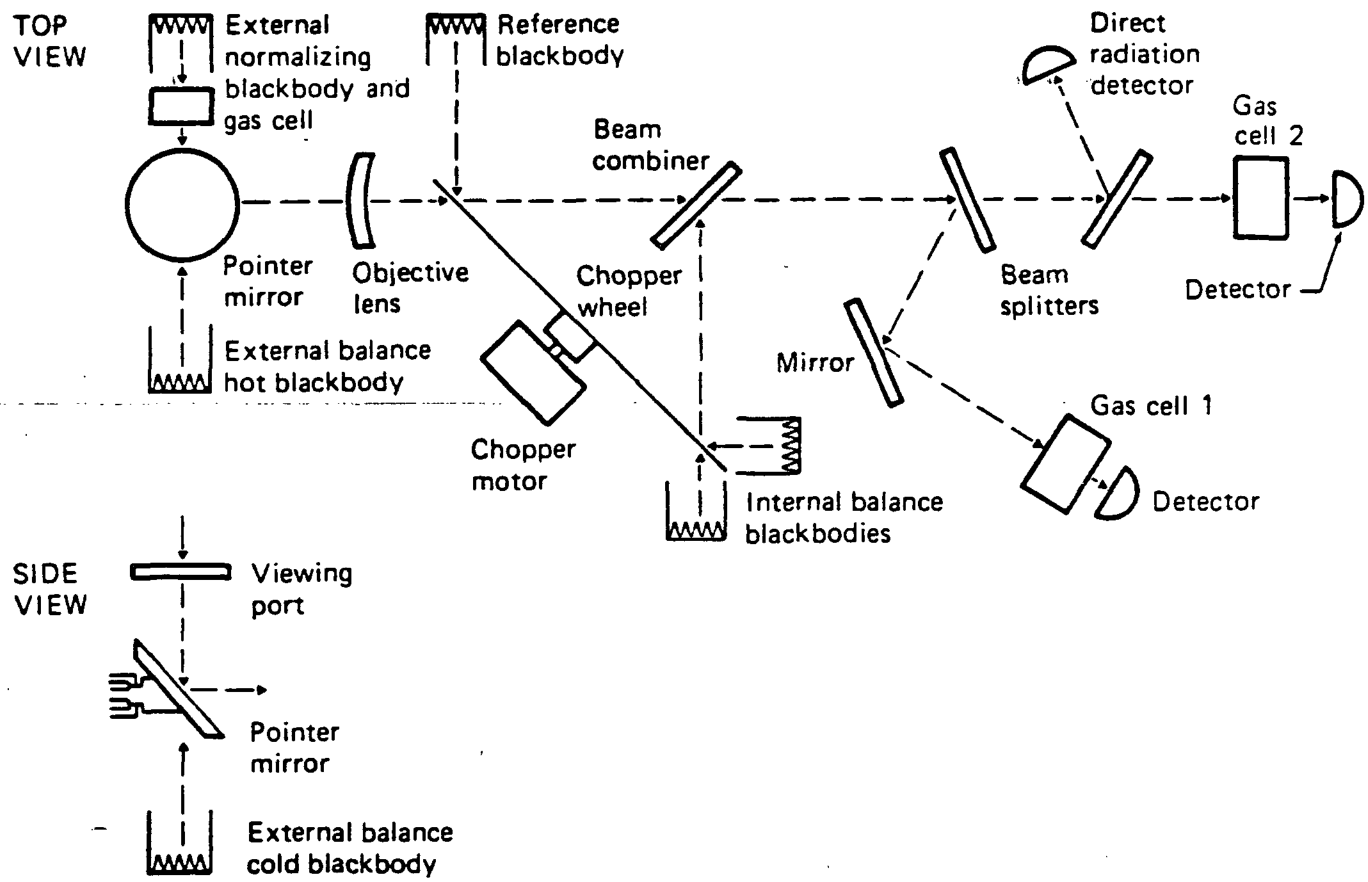


Figure 3.4-4. The MAPS Instrument Calibration Scheme

3.4.3.2 Prelaunch Calibration. Prelaunch calibrations are carried out as a normal part of instrument operation in the same manner as described in the preceding section.

3.4.3.3 Inflight Calibration. Since the MAPS equipment is automated to provide self-balance/calibration and only a turn-on function is required for instrument operation, no on-orbit tests or checks are required. There are no communication requirements. Pallet coolant loop temperature and temperature rate information will be required during data acquisition to evaluate command rebalance requirements.

3.4.3.4 Postflight Calibration. The postflight calibration will be carried out at Langley Research Center using the dedicated MAPS calibration facility in the same manner as the preflight calibration was made.

3.4.4 ACCURACY

3.4.4.1 Instrument Accruacy. ± 15-20%.

3.4.4.2 Geometric Accuracy. Shuttle determined.

3.4.4.3 Radiometric Accuracy. ± 2%.

3.5 OCE

3.5.1 INSTRUMENT DESCRIPTION

The OCE instrument is a modified version of the U-2-borne Ocean Color Scanner. It consists of two main modules - the scanner and the electronics. The scanner is mounted on the experiment pallet shelf and the electronics are coupled to a cold plate on the pallet deck. Figure 3.5-1 shows the location of the OCE instrument and its associated electronics package on the OSTA-1 pallet.

The 34-kg scanner module is a cylinder (75 cm long) flattened on one side (27 cm by 23 cm). The instrument components are mounted on an aluminum plate which is divided into four sections by bulkheads. The second section contains the scanner mirror and is equipped with bomb-bay type doors which protect the instrument during ascent and descent. The third section

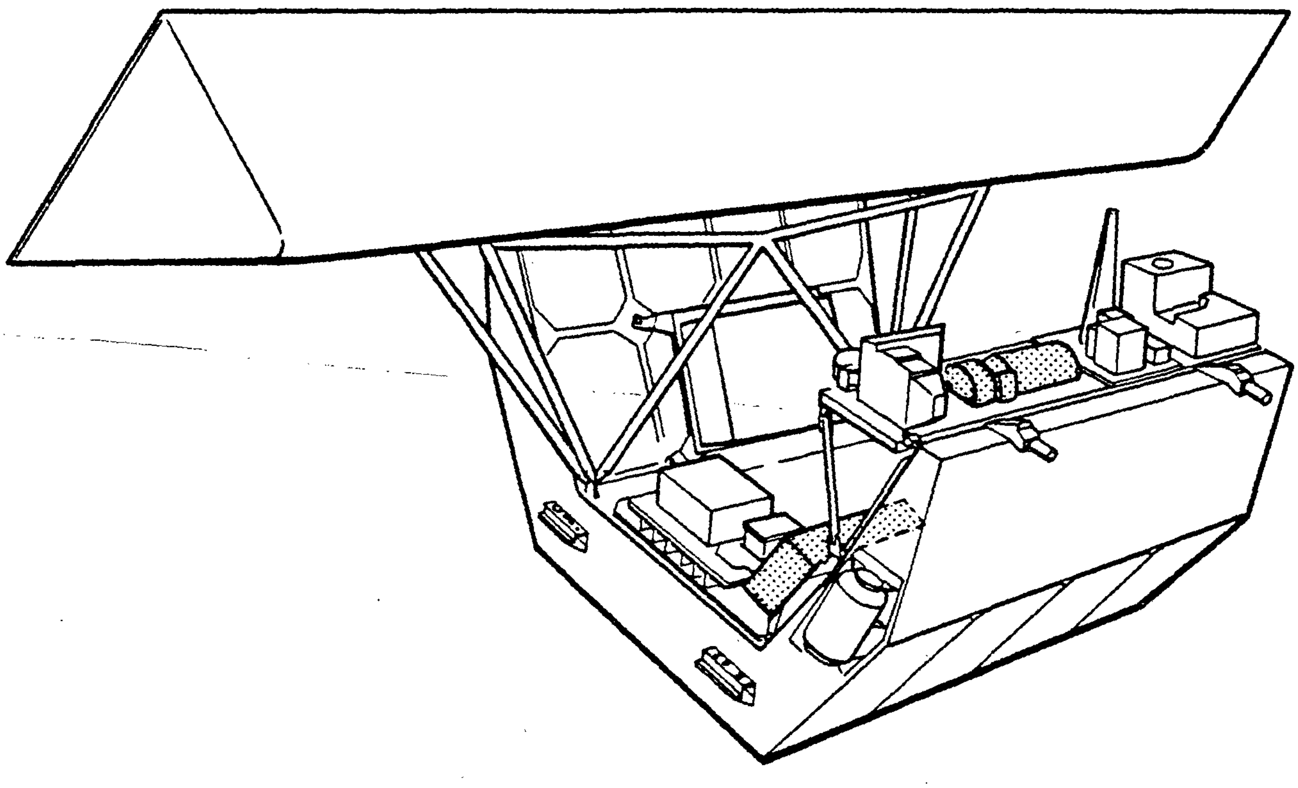


Figure 3.5-1. Location of the OCE Instrument on the OSTA-1 Pallet

contains the telescope. The first section houses the motors for the scanner mirror and doors and the devices for timing pickup. The fourth section houses the optics and an electronics box.

The electronics module weighs 60 kg and measures 29x71x91 cm. It consists of the signal amplifiers, a digitizer, and the data handling system.

The rotating scanner mirror on the OCE instrument scans ± 45 degrees from nadir across the direction of flight and reflects radiation into a Dall-Kirkham telescope. The telescope images the scene through a 1x2 mm field stop and onto a diffraction grating. This diffracted light which has been separated into its component colors is diverted onto a bundle of 24 glass fibers, and a different spectral band is channeled through each glass fiber. The fibers are coupled to 8 silicon photodiode detectors. The center frequency and bandwidths of each of the 8 spectral channels are as listed in Table 3.5-1. Figure 3.5-2 shows the optical diagram of the OCE instrument.

The power requirements at 28 volts D.C. are:

maximum	197 watts
operational	180 watts
standby	50 watts

3.5.2 INSTRUMENT CHARACTERISTICS

IFOV	3.5 mrad
Spatial resolution (sea level)	1 km at nadir
	1.7 km at 40° off nadir
Scan angle	$\pm 45^{\circ}$
Platform altitude	254 km
Spectral resolution	23 nm full width at ½ maximum
Total surface coverage	2.6×10^{7} km^{2}
Data acquisition time	120 min
Sensitivity (chlorophyll concentration)	0.1 mg/m^{3}

Table 3.5-1. OCE Channel Characteristics

Spectral Channel	Center Wavelength (nm)	Bandwidth (nm)	S/N Ratio	Dynamic Range (mW/cm^2-μsr)	Type of Light	Purpose
1	485.9	23	1200:1	0-53.7	Blue	Chlorophyll Absorption (max.) Rayleigh Scattering (atm.)
2	518.4	23	1400:1	0-37.8		Chlorophyll Hinge Point
3	552.6	23	1200:1	0-26.8	Green	Chlorophyll Absorption (min.)
4	584.5	23	1000:1	0-21.0		Backscattering (water and atm.)
5	620.6	23	800:1	0-16.3		Backscattering (water and atm.)
6	655.1	23	800:1	0-13.4	Red	Non-fluorescence band
7	685.1	23	680:1	0-11.6		Chlorophyll fluorescence at 685 nm
8	786.6	52.4	550:1	0-7.5	Near-Infrared	Atm. backscattering (Mie)

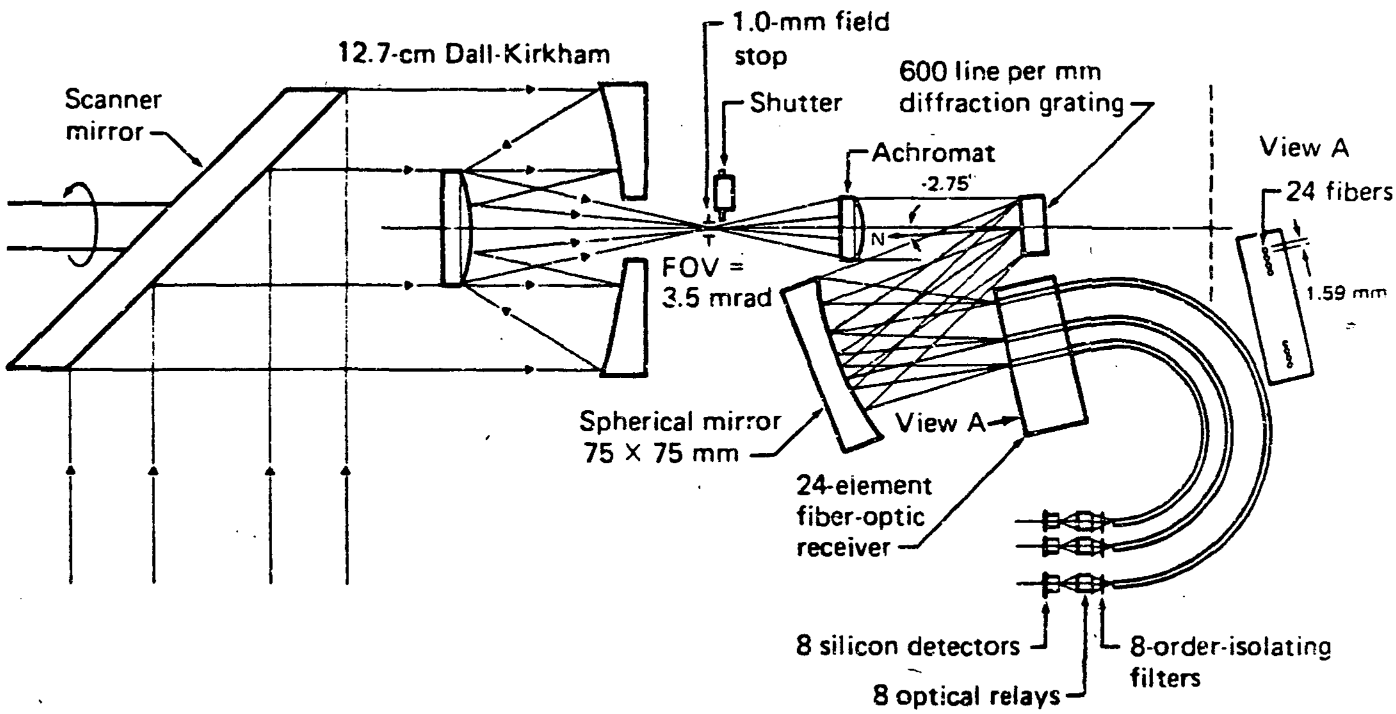


Figure 3.5-2. The OCE Optical Diagram

3.5.3 INSTRUMENT CALIBRATION

3.5.3.1 Preflight Calibration. The spectral irradiance is calibrated against a 1.82 meter integration sphere. The long-term stability of the sphere is about 5% and the OCE irradiance fluctuation is matched to the sphere within a 2% limit.

3.5.3.2 Prelaunch Calibration. A portable diffused light box is used as a calibration standard for spectral irradiance.

3.5.3.3 Inflight Calibration. A low-voltage tungsten lamp is used as a light source to generate staircase calibration between each scan.

3.5.3.4 Postflight Calibration. The OCE will be calibrated against the 1.82 meter integration sphere at GSFC.

3.5.4 ACCURACY

Geometric accuracy will be largely determined by the Orbiter ephemeris data quality. The OCE scanner has a nominal ground resolution of 1 km at nadir and 1.7 km at 45^{o} off-nadir look angle. In order to obtain the OCE system's geometric accuracy, the position information from the Orbiter ephemeris data and the sensor ground resolution have to be incorporated.

Spectral examination of the OCE was carried out using a 0.5-meter Ebert spectrometer and the radiometric phase using a 1.83-meter (6-foot) integrating sphere which is color corrected to approximate the sun's spectral power distribution. The integration sphere at GSFC is calibrated using a number of National Bureau of Standards lamps. The long term stability of the large sphere is about 5%. The OCE instrument was calibrated on May 1979. The instrument is expected to remain within a 2% fluctuation limit of the sphere reading. A full-scale reading of the measured radiance in the 550 nm channel is 8.53 mW/cm^2-microsteradian. This is represented by a reading of 255 counts and all measurements less than full scale are represented linearly. The radiance measurements are accurate to $\pm 5.4\%$.

3.6 NOSL

3.6.1 INSTRUMENT DESCRIPTION

The NOSL instrument consists of the camera, the attached photocell sensor, and the connected tape recorder. Figure 3.6-1 shows how the camera, photocell, and tape recorder are interconnected. The camera is a 16-mm Data Acquisition Camera (DAC) which has been flight tested on Apollo and Skylab missions. The camera will run on 28 Vdc power supplied by the Orbiter. The photocell sensor is mounted on top of the camera, and its field of view is aligned with the camera's. The camera sensor package is 40 cm long, 24 cm wide, and 20 cm high. The photocell/amplifier assembly contains its own battery power supply. The stereo cassette tape recorder is a 25-cm long, 18-cm wide, and 6-cm high Sony TC 124, equipped with a plug-in earphone. The tape recorder interfaces with the photocell, which in turn interfaces with the camera, via connecting wires. The recorder is battery powered.

During launch, boost, and reentry, this instrument will be secured in storage lockers in the crew compartment. In orbit, the instrument will be retrieved and assembled for use in the crew cabin.

Twenty 140-ft. film magazines, two 60-minute tape cassettes, and spare batteries will be kept in a storage apron mounted on the crew cabin wall.

3.6.2 INSTRUMENT CHARACTERISTICS

FOV (Camera)	32^{o} X 24^{o} at 17 mm focal length 6^{o} X 4.5^{o} at 85 mm focal length
FOV (Photodetector)	6^{o} X 6^{o}
Spatial resolution (camera with lens in telephoto position)	100 ft (30 m)
Spatial resolution (photodetector)	15 nautical miles (20 km)

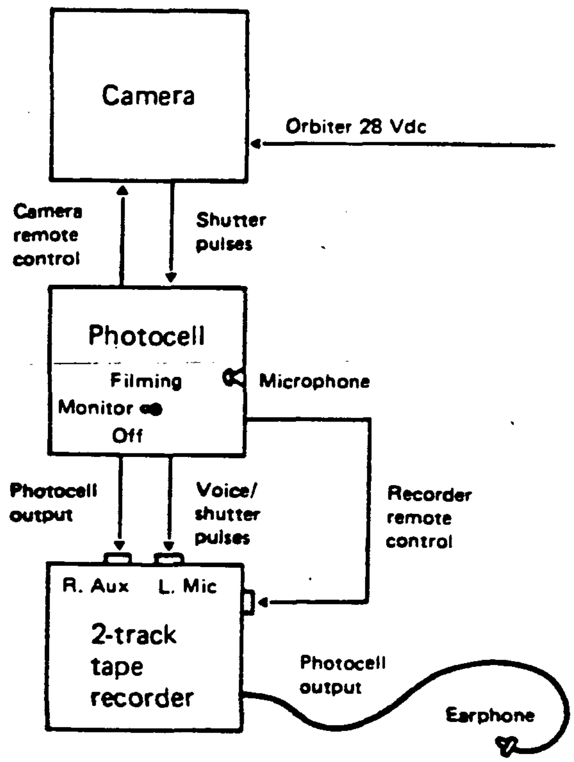


Figure 3.6-1. NOSL Camera, Photocell and Tape Recorder Signal Flow Diagram

3.6.3 INSTRUMENT CALIBRATION

The NOSL equipment calibration consisted of a comparison of photodetector output to that of the experiment hardware of JSC. Signals were comparable. Testing included strobe light detection and angular sensitivity tests. Calibration will be done using equipment at Sandia Laboratories after landing at DFRC.

3.7 HBT

The HBT will use the dwarf sunflower (Helianthus Annuus) as the test medium. A suitcase-like container will be loaded with 85 sealed plant modules varying in soil moisture content from 58 percent by weight (below which plant growth is minimal) to 80 percent (above which anaerobic conditions inhibit growth). The aluminum container is 50 cm high, 43 cm wide, and 24 cm thick. It weighs 21 kg when fully loaded. It contains a battery-powered temperature recorder. This plant carry-on container will be stored in a locker in the crew compartment of the Space Shuttle middeck soon after the modules are planted and loaded as near launch time as feasible. The test will require no crew attention. There are no power, cooling, data, or control interfaces with the Orbiter or crew.

SECTION 4. DATA DESCRIPTION

SECTION 4. DATA DESCRIPTION

The amount, content, format, and storage medium of the data collected in flight by each instrument are described in this section. Those data, other than that collected by the flight instrument, which are necessary to processing or analysis of the flight instrument data, are referred to here as ground truth data and other ancillary data. These data collections or requirements are briefly described here.

An overview of the amount of data collected in flight is summarized in Table 4.0-1. Also given is the disposition of the data by the Mission Manager upon landing of the Orbiter at Dryden Flight Research Center. This disposition is addressed more fully in Section 7, Data Received from Orbiter.

4.1 SIR-A

4.1.1 FLIGHT DATA

The SIR-A image data are recorded on the SIR-A flight film. The film is 70 mm wide by approximately 3650 feet in length by 2.5 mils thick. Film type is Kodak RAR 3493. The film is exposed with a SAR data swath and five auxiliary data channels as shown in Figure 4.1-1. Data swath parameters are film speed, swath width, range focal length, azimuth focal length, range spatial frequency range, and maximum azimuth spatial frequency. Their values are given in Table 4.1-1. Five auxiliary data channels include radar system parameters, sensitivity time control delay, data and timing clock, spacecraft mission elapsed time and re-triggered chirp status. The details of these five channels are given in Figure 4.1-2. The SIR-A signal has a bandwidth of 6 MHz. This limitation was imposed by the bandwidth of the optical recorder. In comparison, the Seasat SAR had a bandwidth of 18 MHz.

Table 4.0-1. OSTA-1 Flight Data Acquisition/Handling

INSTRUMENT	DATA COLLECTION (PERIODS)	DATA TYPE	AMOUNT	MISSION MANAGER ACTIVITY
SIR-A	51	Film	3500 feet	Remove Cassette At DFRC and Provide to P.I.
SMIRR	38	Tape	6.7×10^3 feet	Strip Data from Orbiter Recorder and Provide CCT'S
		Film	1000 frames	Remove Film at DFRC and Process
MAPS	Continuous	Tape	450 feet	Remove Tape at DFRC and Provide to P.I.
		Film	4000 frames	Remove Film at DFRC and Process
OCE	44	Tape	2.8×10^4 feet	Provide CCT'S from Orbiter Recorder
				Provide Copy of MAPS Film
FILE	120 (Automatic)	Tape	450 feet	Remove Tape at DFRC and Provide to P.I.
		Film	120 Frames	Remove Film at DFRC and Process
NOSL	10-20	Tape	800 feet	Remove at DFRC and Provide to P.I.
		Film	7×10^4 frames	
HBT	Continuous	Tape, Specimens		Remove at DFRC and Provide to P.I.

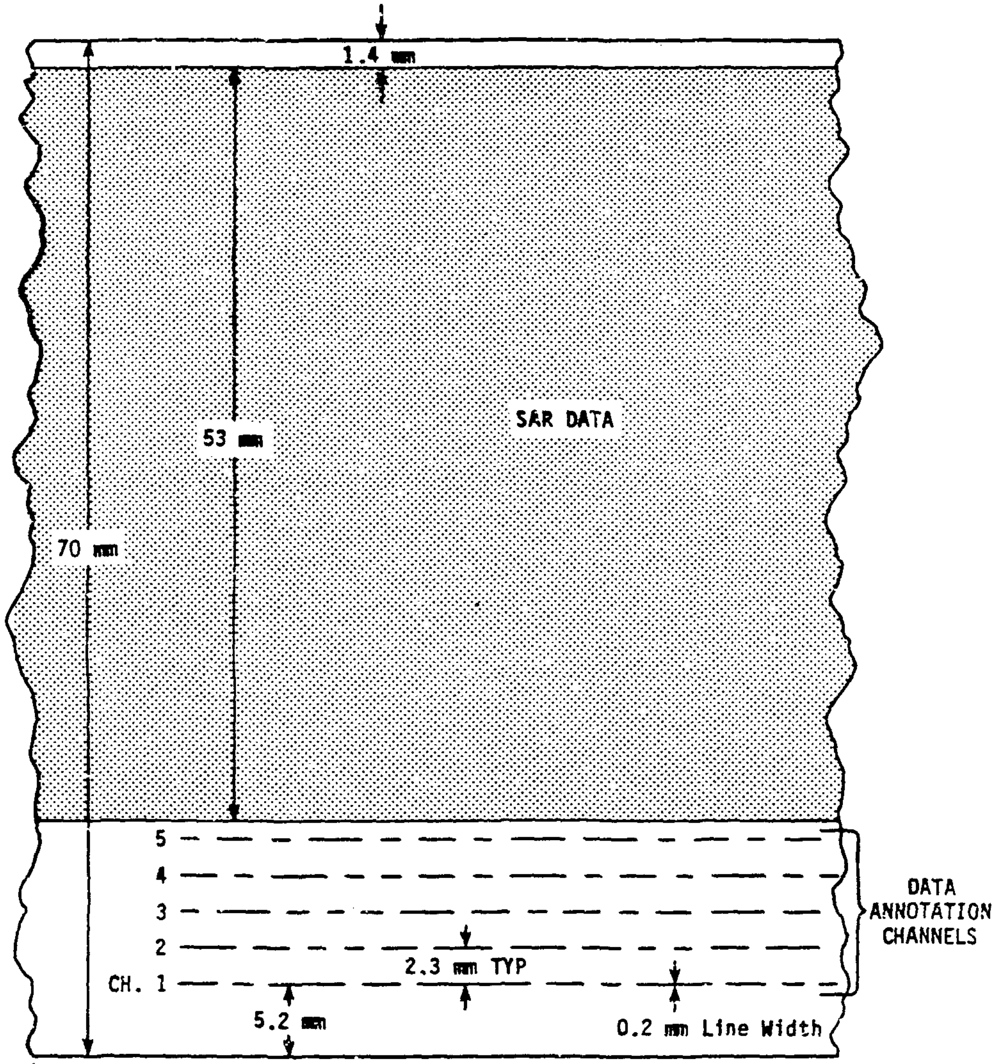


Figure 4.1-1. SIR-A Signal Film Layout

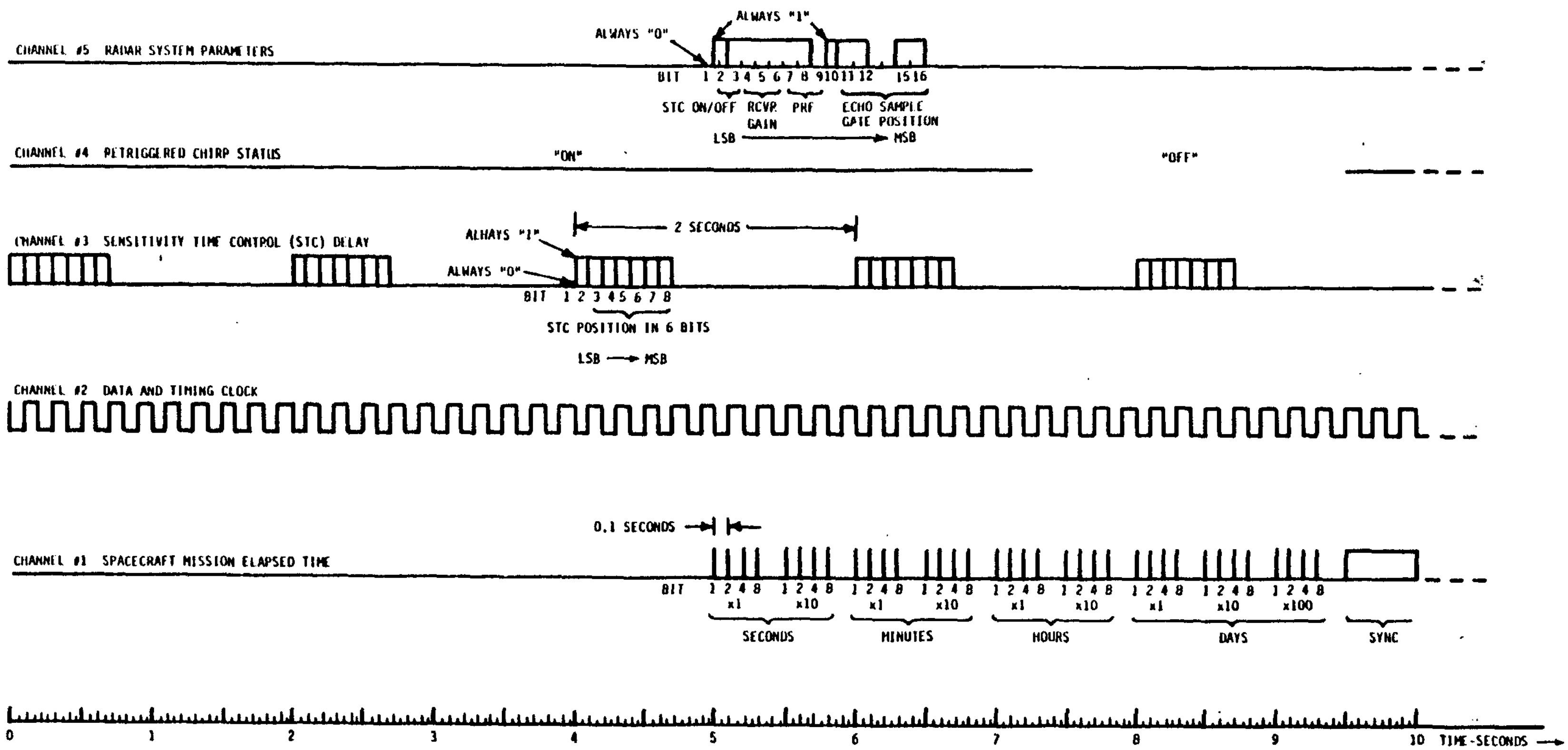


Figure 4.1-2. SIR-A Optical Recorder Data Annotation

Table 4.1-1. SIR-A Data Swath Parameters

Data Swath Parameters	Value
Film speed	37 mm/sec. nominal
Swath width	50.2 km
Range focal length	300 mm
Azimuth focal length	2 meters
Range spatial frequency range	3-34 cycles/mm
Azimuth spatial frequency maximum	44 cycles/mm

4.1.2 GROUND TRUTH AND ANCILLARY DATA

4.1.2.1 Simultaneous or Near-Real-Time Ground Truth. There is no simultaneous ground truth information required for this experiment.

4.1.2.2 Other Ground Truth or Ancillary Data Spacecraft time, radar status parameters, and orbital parameters which will be stored on microfiche in real time are required. This information is required to set-up for SAR data correlation. The microfiche is generated by JSC during the flight and will be sent to the Principal Investigator approximately one to two weeks after Shuttle landing. The formats of microfiche data are described in the JSC document JSC-16196, October 1979, with letter changes.

Calibration data on the film will include sensitometric wedges, MTF/ATF square-wave patterns, and bias only reference, all at the beginning of the film.

JPL will receive from the Mathematical Physics Branch/Mission Planning and Analysis Division (MPB/MPAD) of JSC, a 9-track, 1600-bpi tape which will contain trajectory and attitude data for the STS-2 mission. This tape will be processed by JPL to obtain formatted position and engineering data for use in the correlation of the optical recorder film.

Other ground truth and ancillary data which has been collected in studies by each Investigator for his test sites are given as follows:

- <u>C. Elachi, R. S. Saunders and other JPL collaborators</u>

  - Lineament mapping in the Knoxville, Tennessee region. Simultaneous analysis of radar/Landsat/Seasat will be done. This test is being extended to other regions in the Appalachians.

  - Texture analysis for surface unit mapping. A quantitative technique for texture discrimination is being developed. This technique will be applied using Seasat data over Jamaica, Central America and other Caribbean Islands with heavy vegetation cover.

  - Lithologic units discrimination using radar image tone (San Rafael Swell, Utah). Landsat and Seasat data have been acquired.

  - Classification of volcanic fields and sand dune fields in western U.S. using Seasat-A data. Seasat data and aircraft scatterometer data have already been acquired.

  - Radar data analysis of Geosat test sites.

- <u>H. Macdonald (U. of Arkansas) and collaborators</u>

  Arkansas test site: Lineament analysis

  - Data set now includes: aircraft L-band radar, aircraft X-band radar (RAR, SAR), aircraft Ka-band radar, Seasat-A, Landsat and ground mapping.

  - Detailed report on available data analysis has been completed.

  Gulf Coast Test Site:

  - Work is in progress on analysis of available data over the Lousiana test site: Landsat, Seasat, aircraft Ka-band radar, Skylab, IR color photography.

- Work has been started on the Houston--Brownsville coast area: land use and and ground cover maps have been obtained, ground truth checking has been initiated.

Panama and Columbia:

- Ka-band radar imagery has been obtained and mosaics have been prepared.

- Reconnaissance geologic maps of Columbia test site are being prepared.

o <u>L. Dellwig (U. of Kansas) and collaborators</u>

- Work is underway on preparatory analysis of the Baja California test site using Seasat/Landsat data.

- Work has been conducted on Togo aircraft radar data. Results will be used in the analysis of the SIR-A data.

- Contacts with Nigerian and Australian colleagues have been established for support in ground truth activities. Other contacts are being established with colleagues in Central America.

o <u>A. England (JSC) and collaborators</u>

- Main test sites are in the Piedmont/coastal plain of the Eastern U.S. Fredericksburg, Virginia is being studied in detail. Other sites are being considered.

- Work is directed mostly toward determining the correlation between geology and forest species in the coastal plains and Piedmont provinces, and how well the radar can detect canopy variations.

- Work emphasis is on the simultaneous use of radar/Landsat data.

- G. Schaber (USGS) and W. E. Brown (JPL)

  - Quantitative work in Death Valley is conducted by using radar backscatter imaging data.

  - Work has been started on the test site in northern Arizona (San Francisco volcanic field). Quantitative work will be extended. Aircraft data and Seasat-A data have been acquired and are being analysed.

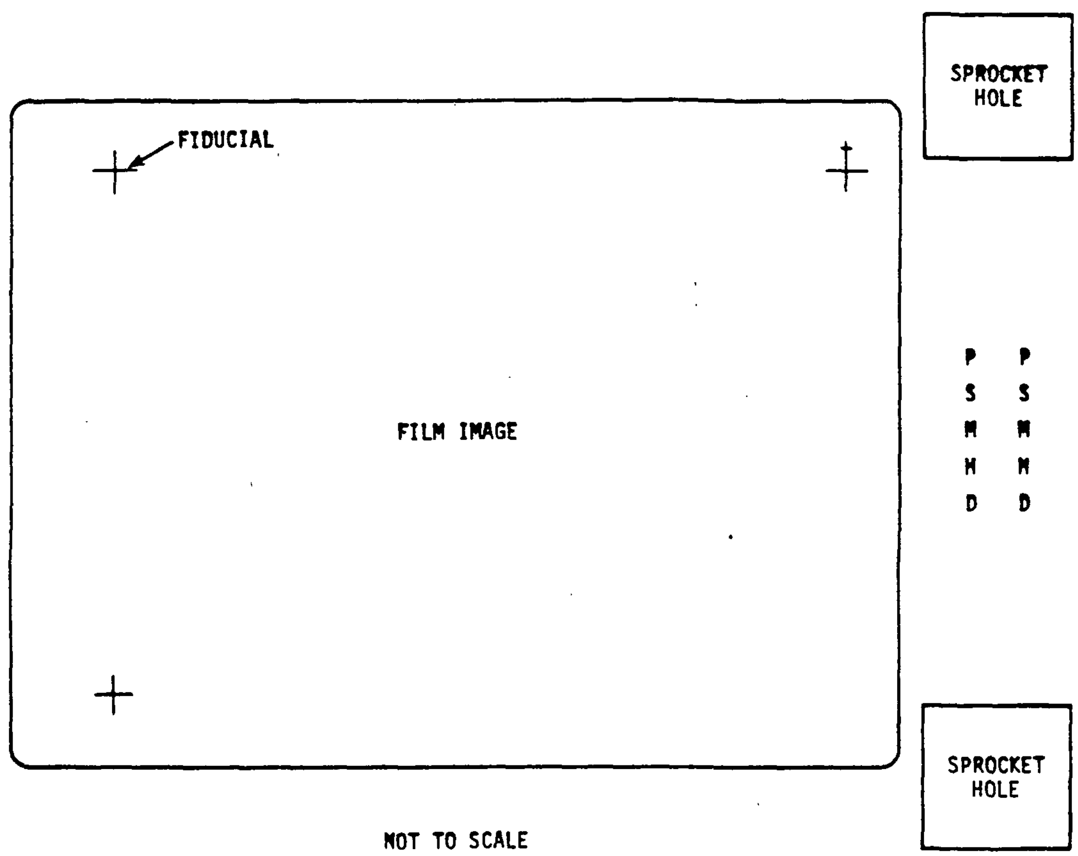
  - Work on volcanic field is being done in cooperation with JPL including classification of volcanic fields radar signature and quantitative modeling.

4.2 SMIRR

4.2.1 FLIGHT DATA

a. PCM Data. The instrument produces 12-bit PCM data output at 36 kilobits per second to the payload recorder. The data are divided into 5760-bit frames, each beginning with a 32-bit pseudo-random noise (PN) word. Each of these frames will constitute one record on the CCTs delivered after the mission. The data are taken when the cold plate is controlled to $7^{o} \pm 5^{o}C$.

b. Film. One camera contains black and white Shellburst film; the other, Ektachrome EF color film. The film is annotated with the event time in the area between sprocket holes (Figure 4.2-1). Temperature constraints on the film mainly concern the time betwen loading the flight film and launch. Once the flight film is installed, it must be changed if it remains in the cameras longer than three months prior to launch or if the ambient temperature of the pallet environment exceeds $80^{o}F$ for a cumulative period of five hours. If the pallet environment is ever warmer than $100^{o}F$ prior to launch, the film must be changed.



4.2-1. SMIRR Film Time Annotation Format

4.2.2 GROUND TRUTH DATA

4.2.2.1 Pre-Mission Data

a. Rock Tests. On three occasions measurements were made of known rock and mineral samples with SMIRR in sunlight. Figure 4.2-2 shows a compilation of ratios of the five channels beginning at 2.1 µm. Pure samples of koalinite and montmorillonite minerals and basalt and rhyolite rocks were made in order to obtain data against which to compare aircraft flight data as well as Shuttle mission data.

b. Aircraft Flight Tests. On two occasions in May 1979 and August 1980, SMIRR was mounted in the JPL Queenair aircraft and flown over 10 test sites in Nevada and Utah in order to obtain data with which to test SMIRR in simulated flight conditions. Data analysis procedures were developed and will also be used to reduce Shuttle flight data. Tests also were made of the ability to position the radiometer field of view within the camera images. The aircraft flights were successful in all aspects. Figure 4.2-3 shows a segment of a flight line across the Lone Mountain, Nevada Test Site. Two major rock units consisting of a limonitic marble and a limonitic granodiorite were present, and in Figure 4.2-3 a plot of the ratios of the two short wavelength channels and the two long wavelength channels are shown. The short wavelength channel data, equivalent to Landsat bands four and five, do not show separation between the marble and the granodiorite. However, the long wavelength data show a clear separation because of the sharply reduced reflectance of the marble in the 2.35 micron carbonate band.

4.2.2.2 Post-mission Data

a. Calibration. SMIRR will be removed from the pallet at KSC and delivered to JPL. A post-flight calibration will be made using the internal calibration lamps and the light cannon. Rock tests with the same samples used in the preflight rock test will be made. These tests will point out any anomalies that may have been present during the flight.

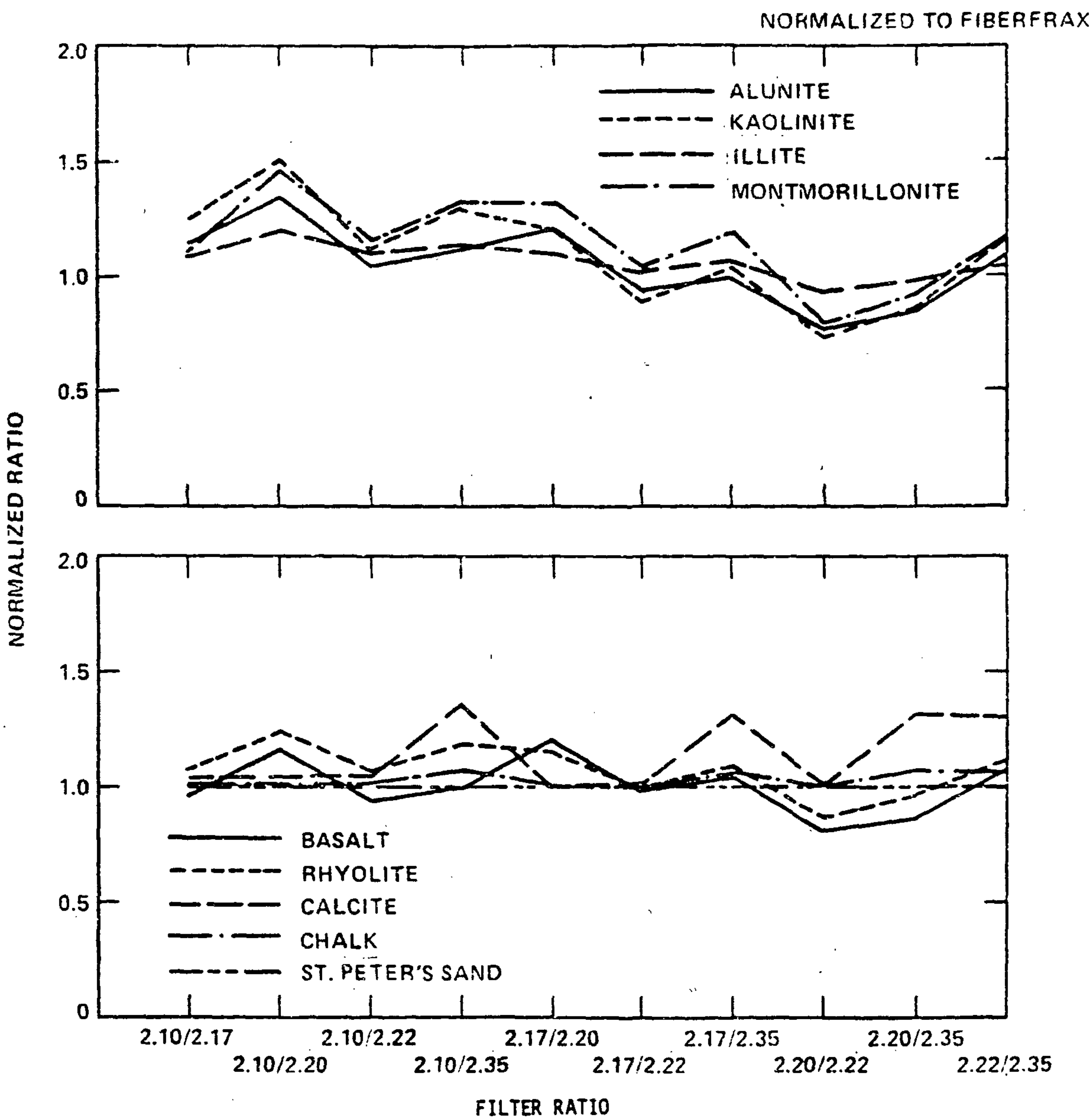


Figure 4.2-2. Final SMIRR Rock Test

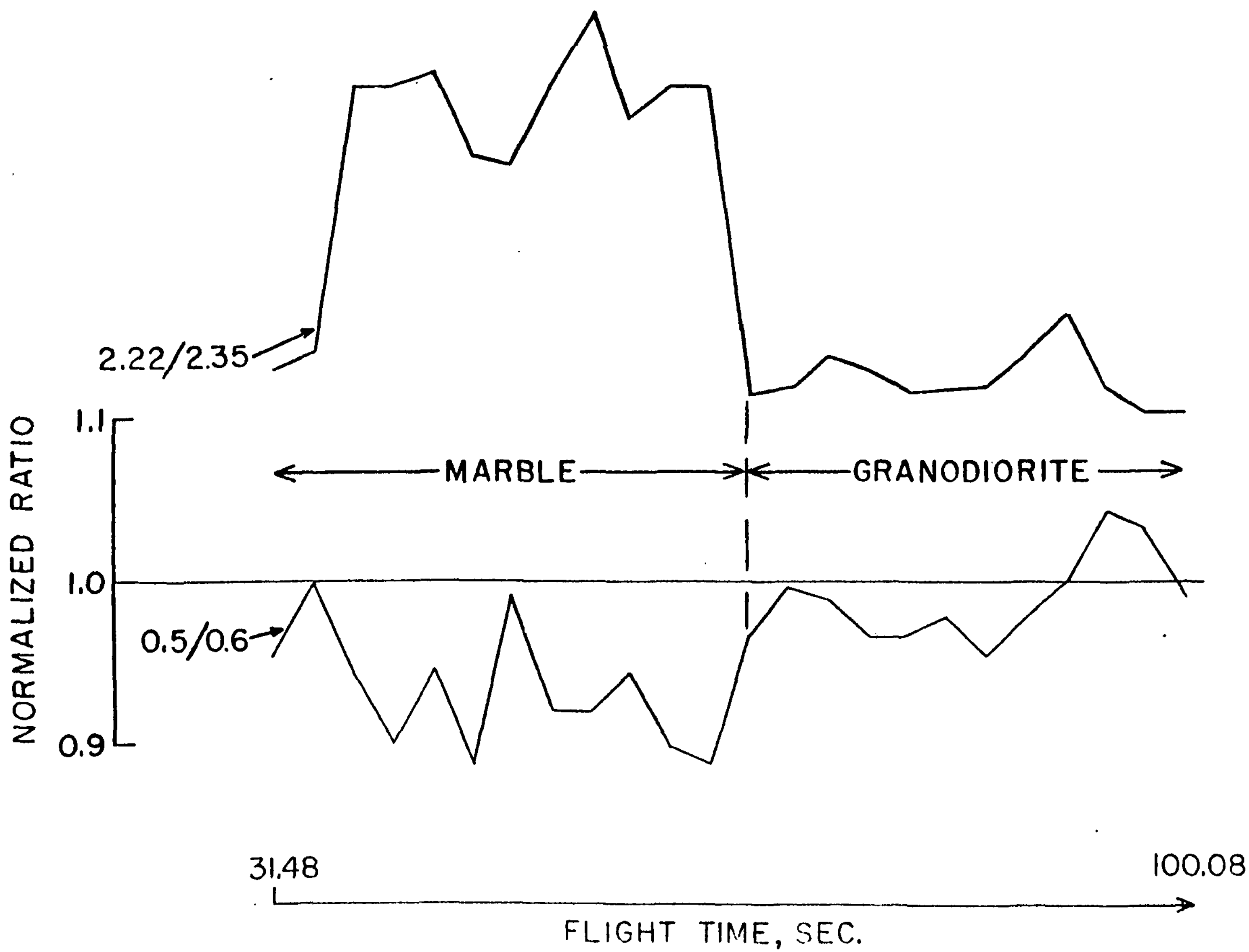


Figure 4.2-3. SMIRR Aircraft Data-Lone Mountain, Nevada

b. Ground Truth. Based on the preliminary data processing and analysis, areas will be chosen within the US and in other important areas in the world for sample collection and measurement. These measurements will be made in order to verify anomalies and determine whether they were induced by the atmosphere or a peculiar mineralogy or environmental condition. A portable instrument called the Hand-held Ratioing Radiometer, incorporating the same ten filters found in SMIRR, will be used to make selected measurements of ratios of spectral bands. These ground truth data will be used in the subsequent data analysis phases.

4.3 FILE

4.3.1 FLIGHT DATA

The flight data will consist of the following:

a. About 120 imagery frames (100 x 100 picture elements, or pixels) of TV-type (CCD solid-state array) camera imagery, for each of two spectral bands, one at 0.65 μm and the other at 0.85 μm. For each band the image (reflectance) will be digitally stored on the FILE magnetic tape. (Lockheed Mark V tape recorder)

b. In-flight feature classification for each of the 120 Earth images via ratioing the two bands of electronic camera data on a pixel-by-pixel basis. The feature classification information is stored on the FILE magnetic tape, i.e., the number of pixels for each frame classified as water, vegetation, and clouds/snow/ice.

c. 70-mm Kodak QX-824 color film exposures, one image for each set (2 bands) of CCD imagery.

d. Time of data taking, referenced to Greenwich Mean Time, stored on FILE magnetic tape.

e. Cloud reference value, stored on the FILE magnetic tape.

4.3.2 GROUND TRUTH AND ANCILLARY DATA

4.3.2.1 Simultaneous Ground Truth and Ancillary Data. The ground truth consisting of photographic imagery is supplied by the 70-mm camera that is part of the FILE experiment. In addition, the MAPS color IR photography will be examined for possible correlation with the FILE color photography to possibly provide additional useful ground truth data. Landsat scenes of some areas may be ordered post-flight.

4.3.2.2 Ancillary Data. Premission data required consists of the mission profile and postmission data consists of the mission ephemeris data.

4.4 MAPS

4.4.1 FLIGHT DATA

Primary MAPS data are digitized and stored on a dedicated Lockheed tape recorder that is a part of the MAPS experiment package. The recorder has sufficient capacity for a 105-hour mission. A 35-mm Flight Research Inc. camera acquires overlapping pictures of the underlying surface during daylight portions of the orbit. Camera operation is automatic after turn on of the experiment. The film used is Kodak 2443 Aerochrome, a false color infrared film.

The tape recorder survival temperature range is -55°C to +65°C. The film situation is somewhat different in that degradation begins at temperatures above -18°C (0°F) and rapidly accelerates as the temperature increases. Tests have indicated that the degradation is unaffected by film exposure. For the time periods to be encountered during the OSTA-1 program, it is felt that the following temperature-time limits will keep the degradation within acceptable limits:

$T > 32^{o}C$	45 days or less
$T > 43^{o}C$	less than 8 hours
$T > 54^{o}C$	less than 1 hour

4.4.2 CORRELATIVE AND ANCILLARY DATA

The correlative measurements needed for the MAPS experiment will be made by a Learjet aircraft and a Convair 990. The Learjet will operate out of LeRC, and it will carry a prototype of the OSTA-1 instrument, equipment for obtaining _in situ_ gas samples, navigational information and meteorological data. It is anticipated that the Learjet and instrumentation will be flown in connection with the mission simulation exercise. Weather conditions will play a major role in the operation of the aircraft. Cloud free conditions are required for the acquisition of the most useful data. The Convair 990 is expected to operate out of ARC, carrying instrumentation to obtain _in situ_ gas samples and meteorological data. Ground track estimates from JSC will be used to match the flight path and flight time of these aircraft with that of STS-2 overpasses.

The aircraft measurements are summarized in Table 4.4-1. Geostationary Operational Environmental Satellite (GOES) cloud cover imagery will be ordered after the data collection is completed to supplement the MAPS camera results. This is desirable but not mandatory. Primary data analysis will be done over clear or cloud-filled sites.

NOAA and/or Navy weather data (from the Fleet Numerical Oceanigraphic Central, Monterey, California) sites will be selected after the post-flight data is screened.

Detailed analysis of the Shuttle data will start with results obtained over the ground-truth sites where the maximum supporting data exists. For local surface position, the subsatellite point will be required to within 10 miles and the spacecraft attitude to within $\pm 5^{\circ}$.

4.5 OCE

4.5.1 FLIGHT DATA

The OCE colorimetric data are recorded on the payload tape recorder. The on-board OCE data system includes a digitizer which pre-processes the 8-channel radiometric signal to 10-bit binary words in PCM format. The digitized data along with the selected engineering analog data are fed into

Table 4.4-1. MAPS Correlative Measurements

	EAST COAST		WEST COAST
Aircraft	LeRC Learjet		ARC CV 990
Area of Operation	$35^oN - 40^oN$, $70^oW - 90^oW$		$35^oN - 40^oN$, $130^oW - 140^oW$
Altitude Range	Surface to 41000 ft.		Surface to 41000 ft.
Base of Operation	LeRC		ARC
Underflight of Shuttle Orbits	Primary	Possible	TBD
	18, 19	20	
	34, 35	33	
	50, 51	49	
Measurements			
- CO Concentrations	MAPS/TRW Brassboard Instrument *In situ* Grab Samples (Gas Analysis)		GASP Instrument *In situ* Grab Samples
- Tair(z)	Air Temperature as Function of Altitude		Same
- Tdp(z)	Dew Point as Function of Altitude		Same
- Hp	Pressure Altitude		Same
- L/L	Latitude/Longitude		Same
- Ground Track	35 mm Camera		Same
Special Radiosonde Launches	TBD		TBD

the payload 14-track tape recorder. The payload tape recorder will be time shared with SMIRR investigators. For OCE, about 120 minutes of viewing time containing about 2 billion bits of data are assigned and the data content is equivalent to a 2.6 X $10^7 km^2$ of ocean area.

STS-2/OSTA-1 has provisions to downlink telemetric data, whenever possible, to the investigators at Payload Operations Control Center (POCC). The telemetric data consists of the various temperatures of the OCE system and several discrete status indicators in five analog and eight digital channels. These are described in subsection 6.1.5.

4.5.2 GROUND TRUTH AND ANCILLARY DATA

4.5.2.1 Simultaneous Ground Truth. *In situ* data collection is an integral part of ocean data gathering. In OCE, the following four *in situ* data collection activities are being planned to support the OCE science. The test sites, means of collecting *in situ* data, and participants in the field activities are as follows:

a. Site 1, Off the Coast of Senegal (W. Africa). The objective of the experiment is to study phytoplankton population in upwelling areas along the Atlantic Gyre's southward flow. The experiment is an international effort in which a West German aircraft carrying NASA's Ocean Color Scanner will conduct underflights to coincide with the Shuttle's overflight. An international agreement on this experiment has been signed between NASA's International Office and the West German Ministry of Research and Technology.

As an alternative, upwelling zones off the coast of Spain are also being considered in the case of adverse weather conditions at the original W. African site.

Participating Investigators:

Heinz van der Piepen, DFVLR, and about 10 others from West Germany
Michel Viollier, University of Lille, France
H.H. Kim, NASA/Goddard Space Flight Center, Greenbelt, Maryland

b. Site 2, Mid-Atlantic Warm Core Eddy Rings. The objective of this experiment is to study the warm core rings which are located in the general areas of $40^{o}N$ latitude and $70^{o}W$ longitude. If the Orbiter flight takes place in September, investigators will make use of a multi-ship operation which is already planned for a time series study of these rings during this month.

Participating Investigators:

P. Wiebe, Woods Hole Oceanographic Institution, Woods Hole, MA
P. La Violette, NORDA, Bay St. Louis, MS

c. Site 3, Off the Coast of the Southeastern US Bight. The objective of this experiment is to study the dynamics and biota of upwelling along the western edge of the Gulf Stream. Shipborne measurements of chlorophyll concentration and other ocean parameters will be taken from the R.V. Bluefin from Skidaway Institute of Oceanography, Savannah, GA, along the Orbiter's ground tracks.

Participating Investigators:

Y.A. Yoder, and L.P. Atkinson, Skidaway Institute of Oceanography, Savannah, GA
C.R. McClain, NASA/Goddard Space Flight Center, Greenbelt, MD

d. Site 4, Central American Coastal Upwelling. The objective of this activity is to investigate Pacific coastal upwelling by correlating OCE imagery with chlorophyll and thermal data obtained by ships. The data obtained will be used to verify an upwelling model being developed by Panamanian, Costa Rican, and U.S. scientists which will help local fisherman predict upwelling phenomena. Since 1978, the University of Delaware has been involved in a five year physical and biological study of the Gulf of Nicoya in Costa Rica. The investigators will schedule some of the monthly cruises to match the Orbiter's overpass tracks.

Participating Investigators:

Vic Klemas, College of Marine Studies, Univ. of Delaware, Newark, DL

M.M. Murillo, Universidad de Costa Rica, San Jose, Costa Rica

R. Legeckis, NOAA/NESS, Washington, DC

4.5.2.2 Real Time Weather Coverage and Ancillary Data. In OCE, both *in situ* and flight activities will be aided by reviewing the real-time weather satellite imagery at POCC. A facsimile unit which receives images from GOES and foreign meteorological satellites will be available to display the cloud coverage of the OCE target areas. Thus, pertinent go/no-go status will be relayed via telephone link to selected field teams. A representative from DFVLR, West Germany, will participate in POCC operations and will relay the OCE mission status to a European underflight team in the field.

The OCE will also use 35-mm photographic film data collected by the MAPS camera on the OSTA-1 payload. The MAPS wide angle field-of-view 35-mm camera covers the total swath of the OCE scanner and provides useful information, i.e., general siting of the OCE field of view and discrimination of surface and cloud features, continental land features, islands, ships, etc. Thus it serves as a useful footprint camera covering the Orbiter's track.

4.5.2.3 Post Mission Data. OCE investigators need the Orbiter's location information and the solar zenith angle at the times of data taking. The JSC Mission office will provide the STS-2 ephemeris data within 14 weeks after the flight. These data will contain the Orbiter's altitude, attitude (IMU corrected), velocity, and the Best Estimate of Trajectory (BET). The information can then be converted into the Earth latitude and longitude coordinates.

4.6 NOSL

4.6.1 FLIGHT DATA

The data taken in the NOSL experiment will comprise motion pictures of thunderstorms taken with a 16-mm color film data acquisition camera and photocell signals produced by lightning in the same area as the photographs recorded on a dual channel cassette recorder. The photographs will show the appearance of convective cloud systems by day and lightning activity in thunderclouds during the night. The data on the tape recorder will give information on the frequency and characteristics of lightning occurring in the field of view of the camera both by day and by night.

4.6.2 GROUND TRUTH AND ANCILLARY DATA

4.6.2.1 Simultaneous or Near-Real-Time Ground Truth. Thunderstorm research centers operated by the University of Florida at Gainesville, by the National Severe Storms Laboratory at Norman, Oklahoma, and by New Mexico Institute of Mining and Technology in Socorro, New Mexico, have been alerted to the NOSL experiment, and they will make observations on lightning occurring during the OSTA-1 mission. Any simultaneous observations made from these observatories on the ground and from the overflying shuttle will be of great value in the interpretation of the data.

Due to the characteristics of the NOSL experiment which is determined from the weather condition and mission timeline, precise ground truth measurement cannot be scheduled in advance.

4.6.2.2 Other Ground Truth or Ancillary Data. Details of the time and place of thunderstorm observations and noteworthy characteristics of these storms will be voice recorded by the crew members on one of the channels of the cassette recorder. There will probably be additional data provided on the operation in the form of notes and interviews obtained during debriefing.

Data extracted from Landsat, GOES and any other pertinent satellite imagery is expected to be used for supporting the studies of NOSL experiment.

4.7 HBT

4.7.1 FLIGHT DATA

A tape recorder in the experiment container will monitor environmental condition.

4.7.2 GROUND TRUTH AND ANCILLARY DATA

A record of the Orbiter cabin air pressure and the middeck locker temperature is required.

SECTION 5. DATA ACQUISITION PLAN

SECTION 5. DATA ACQUISITION PLAN

This section summarizes the intentions for data collection during the flight, as well as considerations affecting data collection, such as changes in flight plans, interactions with the Orbiter, and real-time changes in data plans.

The information in this section is organized by aspects of the Data Acquisition Plan for the convenience of mission users at the time of plan operations. The information for each experiment is stated in each subsection. Since HBT is completely passive in flight and self-contained, it is not discussed here.

The prioritization of all the mission targets is summarized in Table 5.0-1.

5.1 PRIORITY COVERAGE BY AREA AND ACTUAL GROUND COVERAGE

5.1.1 SIR-A

The baseline coverage of SIR-A is shown in Figure 5.1.1-1.

The data acquisition scenario was developed by the SIR-A team using the following criteria which are listed in priority:

a. Coverage over the U.S.; data is acquired during all passes over the U.S. where it is allowed by Shuttle activities.

b. Areas outside the U.S. where a Co-investigator has a test site or has surface truth data already acquired.

c. Areas outside the U.S. where some radar coverage (Seasat or airborne) is available for comparison purposes.

d. Areas which provide a wide variety of climatic and surface cover conditions.

e. Areas where extensive mapping is underway or planned and where the SIR-A data might be useful on an experimental basis.

Table 5.0-1. OSTA-1 Target Prioritization

EXPERIMENTS	PRIME TARGET	SECONDARY TARGET
SIR-A	o U.S. Continent o Central and South America o Africa o Indonesia o Australia o Asia	o Europe o Asia o Spain o Australia o Africa
SMIRR	o U.S. Continent o West Coast of South America o Western and Central Africa o Central Asia o Central Australia	o Central America o Central and Southern Asia o Eastern Africa o Mediterranean o North America o North Australia
OCE	o Off the Coast of S.E. U.S o Off the Coast of W. Africa o Mid-Atlantic warm core rings o East Coast of Japan o West Coast of America	o Off the Coast of Spain o Across the Kuroshio, S. Japan o Off the Coast of S.W. Africa o Off the coast of Costa Rica o Monsoon current in the Indian Ocean
FILE	o Entire subsatellite area	N/A
MAPS	o Entire subsatellite area	N/A
NOSL	N/A	N/A
HBT	N/A	N/A

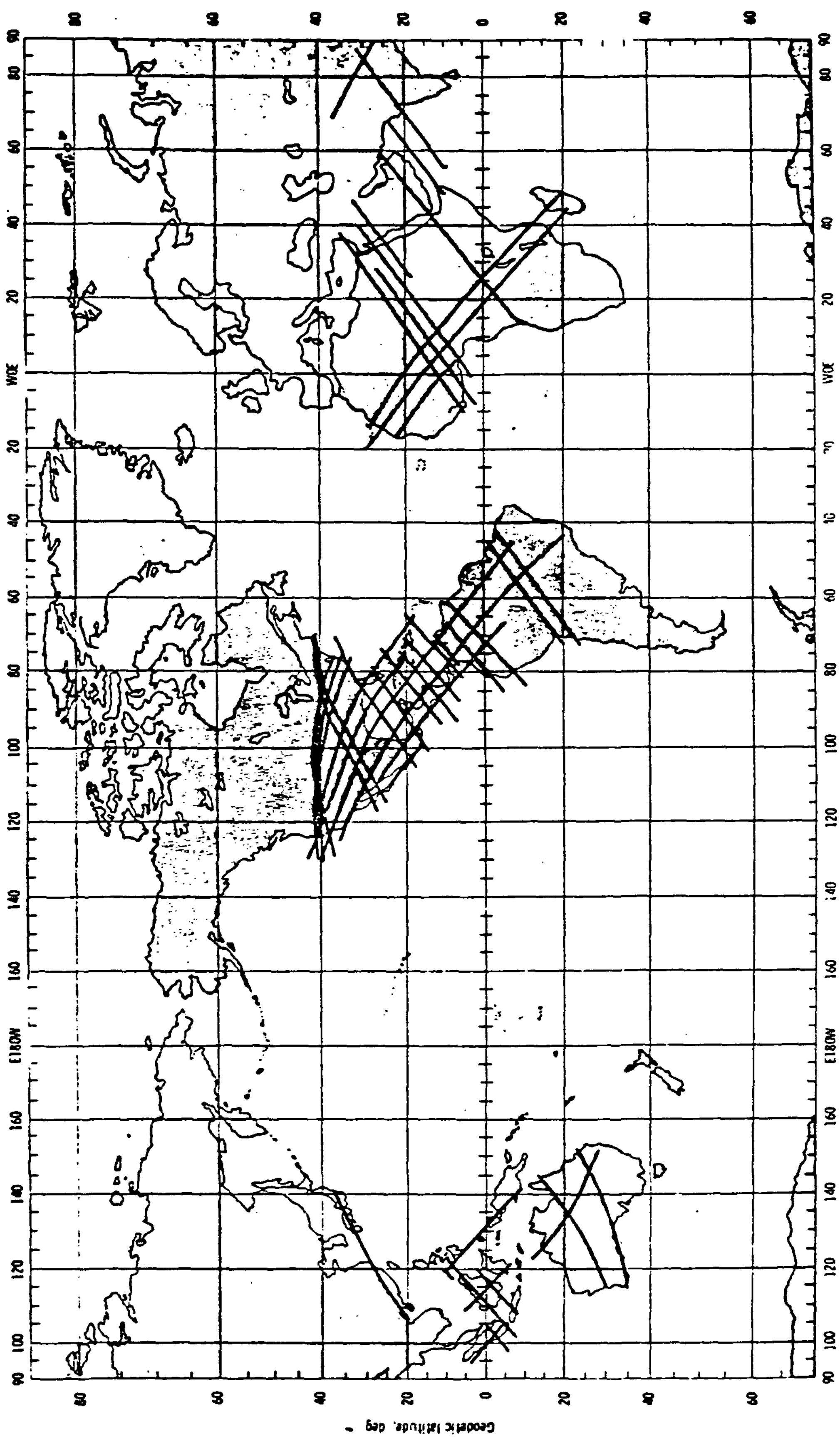


Figure 5.1.1-1. SIR-A Baseline Coverage

Table 5.1.1-1 gives a listing of all the baseline passes and of the backup passes. The backup passes will be used in case some of the baseline passes cannot be achieved due to unforeseen problems during the mission. The backup coverage was selected to provide coverage over geologic regions similar to the ones in the baseline scenario. However, premission ground truth and preparatory work, such as acquisition and analysis of Landsat and aircraft data, will be done only on test sites which are in the baseline scenario.

There is no single site which is absolutely necessary for the success of the SIR-A experiment. Because of the limited capability and the uncertainty associated with the second Shuttle flight characteristics, the coverage was selected such that numerous similar geologic regions are covered. This will allow data acquisition of a wide variety of geologic surfaces even if a good portion of the coverage is not acquired due to problems or changes in the orbital parameters.

In case of unforeseen problems or changes during or immediately before the flight the coverage priority should be as follows:

a. Keep at least three quarters of the passes over the U.S.
b. Keep at least three quarters of the passes over Central America.
c. Keep at least half the passes over Western and Central Africa.
d. Keep at least half the passes over South America.
e. Keep at least two passes over Indonesia and Australia.

5.1.2 SMIRR

Since SMIRR is not an imaging instrument and it is pointed at the nadir, it is impractical to choose specific targets. Therefore, general regions were chosen as primary targets based on the following factors:

a. Geological importance to the objectives of the mission.
b. Accessibility on the ground.
c. Good chance of a cloud-free pass.
d. Variety of geologic units.
e. Local sun angle.

Table 5.1.1-1. Data Acquisition Periods for SIR-A

Orbit No.	Area	Sweep on MET[a,b]	Sweep off MET	Data period M:S	Priority[c]	Latitude,[d] deg. On	Latitude,[d] deg. Off	Longitude,[e] deg. On	Longitude,[e] deg. Off
6	Egr.	00/074500	00/075000	05:00	P(1)	34.6	26.7	-123.3	-103.0
7	Baja	091600	092100	05:00	P(2)	32.6	23.7	-139.5	-120.3
9	Hawaii	122015	122400	03:45	P	23.0	14.6	-164.9	-152.5
12	Africa	161445	162900	14:15	P	02.8	33.1	-008.6	040.1
12	S.A.	173230	174130	09:00	P	-24.8	-03.9	-067.9	-039.3
14	Indonesia	195600	200030	04:30	P	03.1	-08.0	107.3	120.5
15	S.A.	204330	204630	03:00	P	03.7	11.1	-076.0	-067.1
16	C.A.	221545	222045	05:00	P	10.6	22.1	-090.6	-074.5
17	U.S./C.A.	234815	235800	09:45	P	17.8	35.2	-103.9	-066.7
18	U.S.	01/012130	01/013130	10:00	P	25.9	38.0	-113.7	-070.6
18	Australia	021945	022915	09:30	P	-37.6	-24.8	114.9	155.0
19	Australia	035430	040315	08:45	P	-32.2	-14.8	115.9	147.3
20	U.S.	042730	043915	11:45	P	36.3	32.1	-130.0	-075.4
21	U.S.	060345	061845	15:00	P	37.4	11.5	-120.4	-062.8
21	Indonesia	070430	070900	04:30	P	-09.1	02.0	108.8	122.0
22	US/CA/SA	073630	080215	25:45	P	34.4	-22.2	128.1	-042.9
25	Africa	130100	131630	15:30	P	-14.7	24.6	010.3	061.2
27	Africa	144245	144845	06:00	P	17.7	29.9	027.5	048.9
28	S.A.	172500	173330	08:30	P	-22.2	-02.1	-069.2	-042.7
29	Indonesia	181500	182330	08:30	P	10.0	-11.0	116.3	141.4

Table 5.1.1-1. Data Acquisition Periods for SIR-A (cont.)

Orbit No.	Area	Sweep on MET[a,b]	Sweep off MET	Data period M:S	Priority[c]	Latitude,[d] deg. On	Latitude,[d] deg. Off	Longitude,[e] deg. On	Longitude,[e] deg. Off
30	Australia	195430	200230	08:00	P	-14.7	-31.0	123.4	151.6
31	C.A.	203515	204100	05:45	P	05.0	18.7	-080.1	-062.4
33	U.S./C.A.	234100	235115	10:15	P	21.2	37.0	-104.4	-062.9
34	U.S.	011345	012430	10:15	P	27.9	38.1	-115.4	-067.4
34	Africa	02/013530	02/015630	21:00	P	25.2	-24.0	-019.9	046.0
35	U.S.	041930	043145	12:15	P	37.0	30.0	-131.8	-075.5
37	U.S.	055345	060800	14:15	P	37.9	16.1	-131.5	-073.3
37	Indonesia	065600	070415	08:15	P	-08.3	12.1	104.2	128.6
38	C.A.	073000	075415	24:15	P	31.1	-24.0	-123.8	-045.5
41	Asia	112945	114145	12:00	P	05.2	31.2	051.6	092.2
43	Africa	142745	144000	12:15	P	03.0	30.1	003.4	044.0
45	Asia	175430	180100	06:30	P	33.4	21.7	069.8	094.6
45	S.A.	185130	185900	07:30	P	-08.3	10.2	-078.5	-056.4
47	C.A.	202645	203230	05:45	P	06.1	19.8	-084.3	-066.4
48	U.S./C.A.	215900	220600	07:00	P	13.0	28.1	-098.7	-074.8
49	U.S./C.A.	233200	234215	10:15	P	21.2	37.0	-110.0	-068.5
51	U.S.	03/023900	03/024945	10:45	P	35.1	35.1	-123.9	-073.2
53	US/CA/SA	054545	061100	25:15	P	37.5	-13.3	-132.1	-044.0
53	Indonesia	064800	065030	02:30	P	-05.7	00.5	101.8	109.1
54	C.A.	072330	072945	06:15	P	26.6	12.9	-119.5	-098.5
55	Asia	082745	083730	09:45	P	19.3	35.9	110.1	148.2

Table 5.1.1-1. Data Acquisition Periods for SIA-A (cont.) 8/25/81

Orbit No.	Area	Sweep on MET[a,b]	Sweep off MET	Data period M:S	Priority[c]	Latitude,[d] deg. On	Latitude,[d] deg. Off	Longitude,[e] deg. On	Longitude,[e] deg. Off
57	Asia	112145	112915	07:30	P	07.8	25.0	049.3	073.5
59	Africa	141845	142945	11:00	P	03.2	28.1	-001.9	034.0
61	S.A.	184345	184945	06:00	P	-04.9	10.0	-080.0	-062.3
62	Indonesia	193115	193445	03:30	P	-02.7	-10.7	097.5	107.1
63	C.A.	201845	202430	06:15	P	08.9	22.3	-086.4	-068.1

Total baseline time (P): 442.15

Total backup time (S): TBS

For September 30, 1981 launch.

[a]Mission Elapse Time.

[b]Film advance is activated 2 second prior to Sweep On Time.

[c]Priority P = Primary area; S = Secondary area; P(1) = preferred data acquisition; P(2) = data taken only if P(1) is not available (not included in baseline time).

[d]Latitude prefix (-) is for South, no prefix is North.

[e]Longitude prefix (-) is for West, no prefix is East.

Figure 5.1.2-1 shows the prime coverage expected from the earlier mission orbit altitude. Figure 5.1.2-2 shows secondary targets. The primary target is coverage in the Western U.S. since it meets all the above-stated criteria and many studies have been carried out in this area over the past 10 years.

Table 5.1.2-1 gives a listing of all the baseline passes and of the backup passes for the SMIRR and OCE. The backup passes will be used in case some of the baseline passes cannot be achieved due to unforeseen problems during the mission.

5.1.3 FILE

FILE data taking is automatically controlled. Images are selectively recorded during high-sun-angle daylight, ZLV periods of the mission.

5.1.4 MAPS

Observations and measurements of tropospheric CO concentrations will be made throughout the Earth-observing period with no prioritization of coverage by area. All the data acquired will be used to determine the interhemispheric mass transport of the gas and to authenticate transport models for CO. Actual ground coverage will be determined by the Shuttle's orbits and the terrain over which the data will be collected will be monitored by the aerial camera which is mounted alongside the MAPS electro-optical head.

5.1.5 OCE

OCE will take data during the Orbiter's daylight passes over the open oceans. The OCE will focus on several predetermined test areas where *in-situ* activities are planned. Table 5.1.2-1 also gives the areas chosen for OCE primary and secondary targets.

Figure 5.1.5-1 shows the prime coverage planned from the OCE data acquisition period for the Atlantic and Indian Oceans and the Pacific Ocean region. Figure 5.1.5-2 shows secondary targets. In order to maximize the probability of successful collection of data in the event that adverse

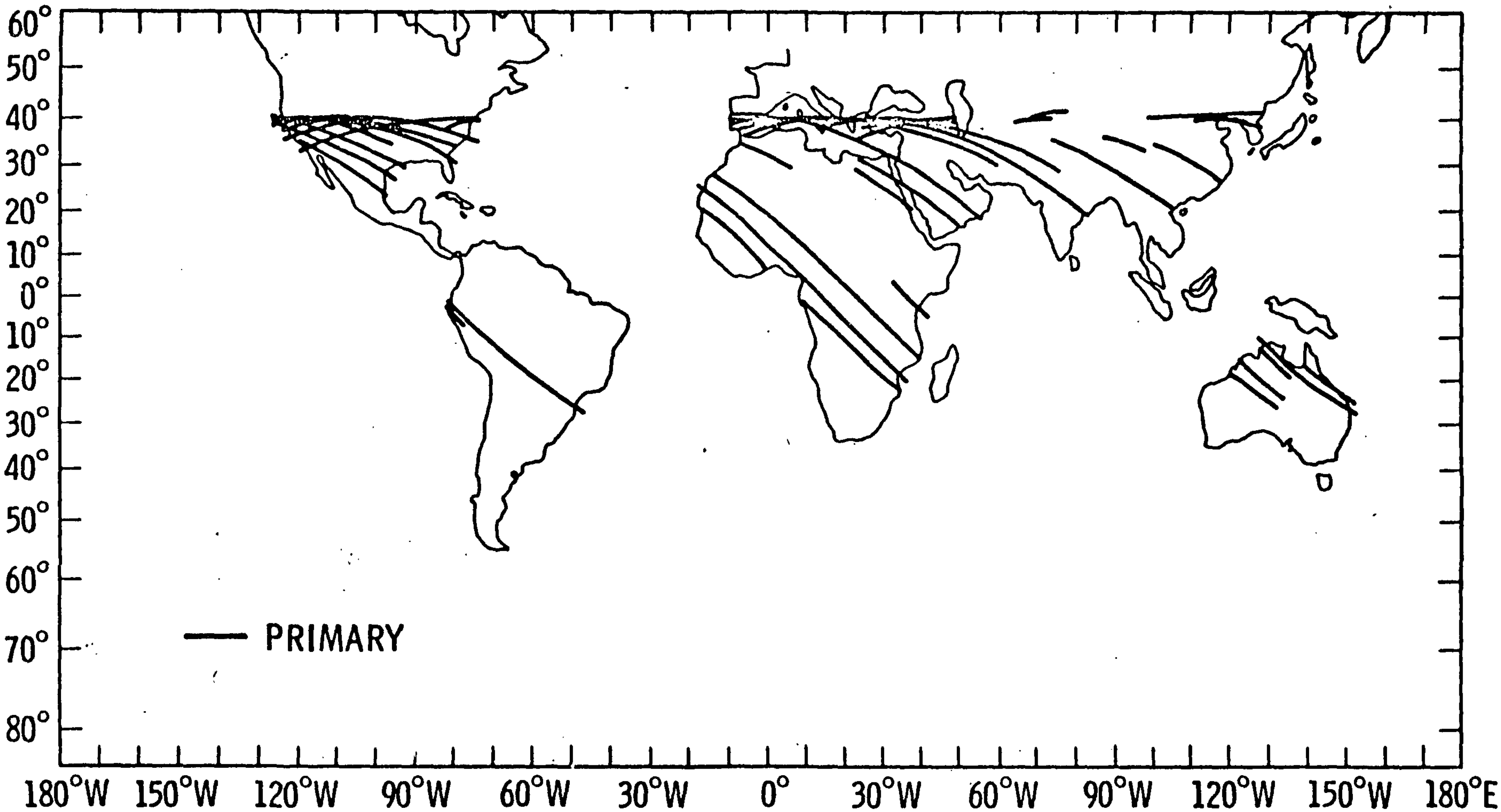


Figure 5.1.2-1. SMIRR Primary Coverage Pattern

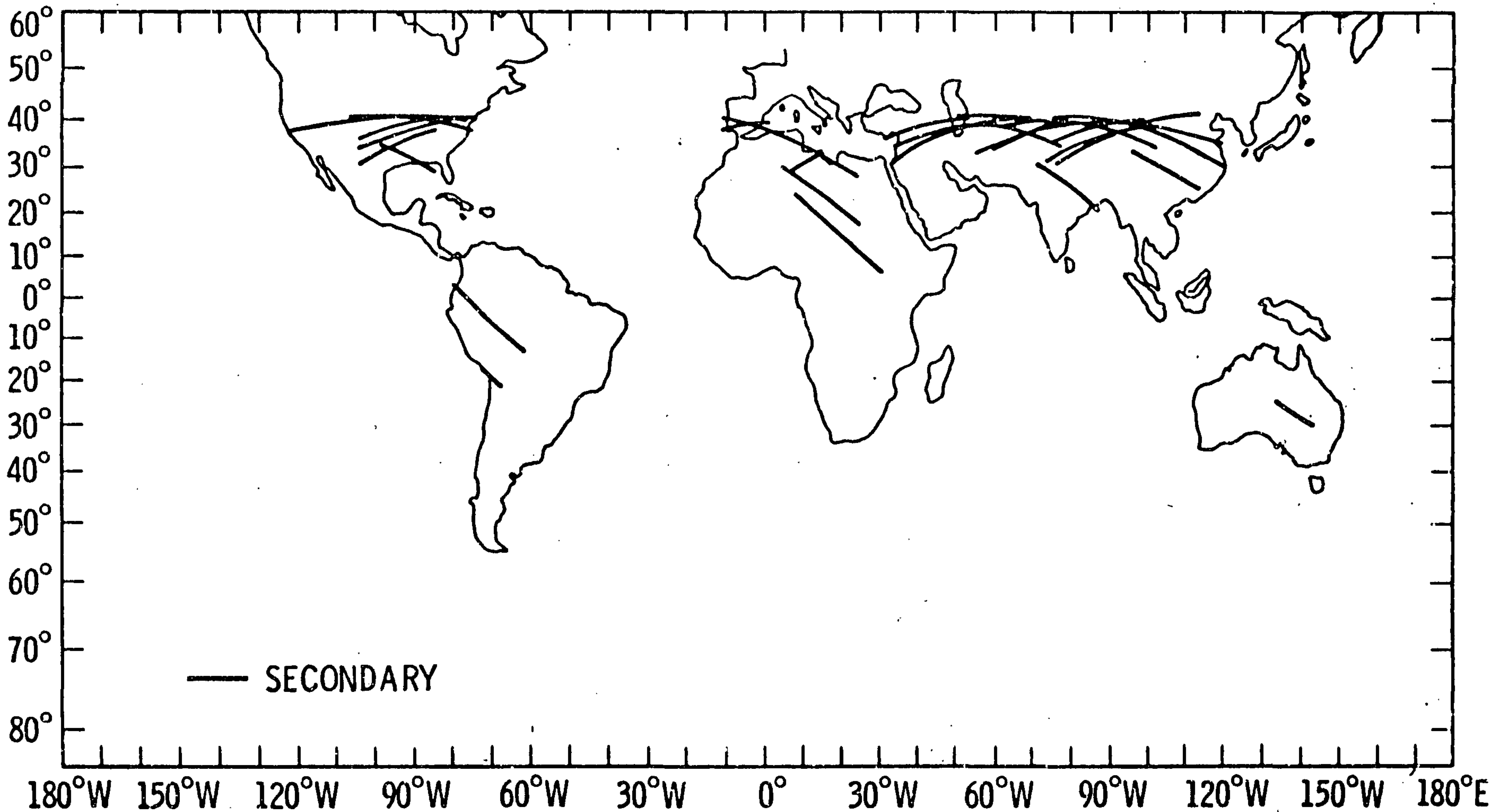


Figure 5.1.2-2. SMIRR Secondary Coverage Pattern

Table 5.1.2-1. *Data Acquisition Period for SMIRR and OCE* 8/25/81

Priority[a] SMIRR	Priority[a] OCE	Orbit No.	Area	MET[b] Start D:HH:MM:SS	MET[b] Stop D:HH:MM:SS	Data period MM:SS	Latitude,[c] deg. Start	Latitude,[c] deg. Stop	Longitude,[d] deg. Start	Longitude,[d] deg. Stop	SEA,[e] deg. Start	SEA,[e] deg. Stop
P		4	U.S.A	0:04:37:30	0:04:41:30	04:00	36.6	38.2	-122.6	-103.4	61.5	49.7
S		4	U.S.A.	0:04:41:30	0:04:47:15	05:45	38.2	34.2	-103.4	-076.3	49.7	37.0
	S	6	U.S.A	0:07:43:15	0:07:46:30	03:15	36.4	32.6	-131.2	-116.8	41.0	35.5
P		6	U.S.A.	0:07:46:15	0:07:51:45	05:30	33.0	23.2	-117.9	-096.7	35.8	34.9
	S	7	Peru	0:09:30:00	0:09:34:45	04:45	02.6	-09.2	-092.0	-078.1	53.3	67.9
P		7	Peru	0:09:34:15	0:09:38:30	04:15	-08.0	-18.0	-079.6	-066.4	66.3	80.2
	S	8	Tokyo-Kuroshio	0:10:33:30	0:10:36:15	02:45	35:8	37:8	141.8	155.9	65.9	56.6
	P	9	Sea of Japan	0:12:05:00	0:12:09:30	04:30	37.4	37.8	128.5	150.2	59.8	46.7
S		10	China	0:13:28:30	0:13:39:30	11:00	30.6	37.5	079.3	129.9	79.6	45.6
	S	10	Sea of Japan	0:13:39:00	0:13:44:00	05:00	37.8	33.1	127.5	150.3	46.9	36.0
S		11	Midde East	0:15:00:15	0:15:02:45	02:30	34.0	36.6	066.0	077.3	72.4	64.2
	P	11	Kyushu	0:15:14:30	0:15:16:45	02:15	31.6	27.8	131.8	140.7	34.7	33.0
S		12	Middle East	0:16:27:30	0:16:33:15	05:45	30.8	37.4	033.9	059.3	80.2	61.3
P		13	Asia Minor	0:18:00:00	0:18:05:30	05:30	35.0	38.2	024.0	049.9	70.5	53.0
P		14	Africa	0:19:28:45	0:19:43:45	15:00	34.2	30.2	-002.0	-066.8	73.2	33.6
S		14	Asia Minor	0:19:43:45	0:19:49:15	05:30	30.2	19.3	066.8	086.6	33.6	34.4
P		14	Australia	0:02:03:00	0:20:05:30	02:30	-14.1	-19.8	128.1	136.2	71.2	79.5
P		15	Spain	0:21:01:30	0:21:03:30	02:00	37.3	38.1	-009.8	-000.3	62.8	56.5
	P	15	Mediterranean	0:21:03:30	0:21:11:00	07:30	38.1	33.5	-000.3	034.8	56.5	36.9
	P	16	Atlantic	0:22:32:30	0:22:35:45	03:15	38.0	37.8	-025.3	-009.6	58.2	48.4
P		16	Spain/Egypt	0:22:35:45	0:22:50:30	14:45	37.8	13.9	-009.6	048.4	48.4	37.4
	P	16	Somalia	0:22:50:30	0:22:56:00	05:30	13.9	00.5	048.4	064.8	37.4	51.5
	P	17	Atlantic	1:00:07:45	1:00:10:30	02:45	36.0	32.7	-020.5	-008.4	41.9	36.9

Table 5.1.2-1. Data Acquisition Period for SMIRR and OCE (cont.)

Priority[a] SMIRR	Priority[a] OCE	Orbit No.	Area	MET[b] Start D:HH:MM:SS	MET[b] Stop D:HH:MM:SS	Data period MM:SS	Latitude,[c] deg. Start	Latitude,[c] deg. Stop	Longitude,[d] deg. Start	Longitude,[d] deg. Stop	SEA,[e] deg. Start	SEA,[e] deg. Stop
P		17	Africa	1:00:10:15	1:00:14:15	04:00	33.1	26.3	-009.5	006.4	36.4	31.8
S		17	Africa	1:00:14:15	1:00:25:45	11:45	26:3	-00.3	006.4	042.8	31.8	51.9
S		18	U.S.A.	1:01:25:15	1:01:28:15	03:00	32.4	36.0	-099.1	-086.0	79.3	69.2
P		18	U.S.A.	1:01:28:15	1:01:30:15	02:00	36.0	37.5	-086.0	-076.6	69.2	62.6
	P	18	Atlantic	1:01:30:30	1:01:35:45	05:15	37.6	37.1	-075.4	-050.1	61.8	45.9
S		18	Africa	1:01:44:00	1:01:48:00	04:00	25.8	17.2	-015.4	-001.8	31.6	34.2
P		18	Africa	1:01:48:00	1:02:02:00	14:00	17.2	-16.8	-001.8	040.4	34.2	40.4
P		19	U.S.A.	1:02:55:15	1:03:04:30	09:15	33.1	37.6	-119.6	-076.3	77.8	48.1
	P	19	Mid-Atlantic	1:03:04:45	1:03:09:15	04:30	37.5	33.0	-075.1	-054.8	47.4	36.3
	P	19	Senegal-W.A.	1:03:15:45	1:03:19:45	04:00	21.0	11.8	-030.2	-017.4	32.0	38.0
P		20	U.S.A.	1:04:29:00	1:04:38:15	09:15	37.4	33.6	-123.0	-079.6	63.8	36.9
	S	20	Atlantic	1:04:38:30	1:04:41:45	03:15	33.2	28.0	-078.5	-065.4	36.9	32.0
	P	21	Pacific	1:06:00:30	1:06:03:00	02:30	38.1	37.8	-136.1	-124.0	57.6	49.8
P		21	U.S.A.	1:06:03:00	1:06:09:15	06:15	37.8	31.3	-124.0	-096.0	49.8	34.5
S		21	U.S.A.	1:06:09:15	1:06:10:45	01:30	31.3	28.8	-096.0	-090.0	34.5	32.4
	P	22	Pacific	1:07:36:00	1:07:39:30	03:30	35.0	30.0	-130.3	-115.6	40.3	33.3
P		22	Mexico/C.A.	1:07:39:15	1:07:50:15	11:00	30.4	06.0	-116.6	-079.5	33.7	41.7
S		23	Chile-Bolivia	1:09:30:15	1:09:32:00	01:45	-18.5	-22.8	-071.5	-064.7	73.4	80.2
	P	25	N. Japan-Pacific	1:12:00:15	1:12:03:00	02:45	38.0	36.3	142.0	155.0	52.7	44.4
S		26	China	1:13:21:45	1:13:25:30	03:45	33.6	37.0	081.8	096.5	79.6	66.7
P		26	China	1:13:25:30	1:13:32:00	06:30	37.0	36.7	096.5	130.0	66.7	46.0
	P	26	Sea of Japan	1:13:31:45	1:13:36:30	04:45	36.9	31.3	128.9	149.8	46.7	34.8
S		27	China	1:14:51:15	1:15:04:30	13:15	33.7	33.4	059.2	120.9	79.8	38.1

Table 5.1.2-1. Data Acquisition Period for SMIRR and OCE (cont.)

Priority[a] SMIRR	Priority[a] OCE	Orbit No.	Area	MET[b] Start D:HH:MM:SS	MET[b] Stop D:HH:MM:SS	Data period MM:SS	Latitude,[c] deg. Start	Latitude,[c] deg. Stop	Longitude,[d] deg. Start	Longitude,[d] deg. Stop	SEA,[e] deg. Start	SEA,[e] deg. Stop
S		28	Middle East	1:16:20:45	1:16:26:45	06:00	33.7	38.2	036.6	064.5	80.0	59.6
P		28	Asia	1:16:26:45	1:16:28:45	02:00	38.2	37.9	064.5	074.1	59.6	53.1
S		28	China	1:16:28:45	1:16:35:00	06:15	37.9	31.9	074.1	102.4	53.1	35.8
P		28	China	1:16:35:00	1:16:40:00	05:00	31.9	22.7	102.4	121.4	35.8	29.5
P		29	Middle East	1:17:53:15	1:17:57:45	04:30	36.9	38.1	027.5	049.1	69.9	54.8
S		29	Asia	1:17:58:00	1:18:01:45	03:45	38.0	35.4	050.4	067.9	54.0	37.5
P		29	SE Asia	1:18:01:45	1:18:12:15	10:30	35.4	16.5	067.9	107.8	42.7	30.7
P		30	Mediterranean	1:19:24:15	1:19:39:15	15:00	37.8	22.0	012.0	076.9	64.9	29.0
S		30	India	1:19:39:15	1:19:41:15	02:00	22.0	17.6	076.9	083.5	29.0	29.9
P		30	Australia	1:19:54:30	1:19:59:00	04:30	-14.7	-24.6	123.3	138.3	64.5	80.1
P		31	Spain	1:20:54:00	1:20:56:00	02:00	37.9	38.2	-009.4	000.3	64.3	57.6
	P	31	Mediterranean	1:20:56:00	1:20:59:00	03:00	38.2	36.9	000.3	014.7	57.6	48.0
	P	32	Atlantic	1:22:26:00	1:22:28:30	02:30	38.0	36.9	-019.8	-007.9	56.1	48.1
P		32	Spain/N. Africa	1:22:29:45	1:22:40:45	11:00	35.8	16.2	-002.1	039.8	44.3	29.8
S		33	Africa	2:00:02:30	2:00:15:00	12:45	31.5	04.6	-010.7	031.5	35.7	38.8
P		33	Africa	2:00:15:00	2:00:18:00	03:00	04.6	-02.9	031.5	040.3	38.8	47.4
S		34	U.S.A.	2:01:18:15	2:01:23:00	04:45	34.8	38.1	-096.9	-074.7	79.6	63.1
	P	34	Mid-Atlantic	2:01:23:00	2:01:27:00	04:00	38.1	37.0	-074.7	-054.3	63.1	49.1
P		34	Africa	2:01:39:00	2:01:54:00	15:00	17.6	-18.6	-008.0	037.4	28.6	68.6
P		35	U.S.A.	2:02:47:30	2:02:51:00	03:30	34.5	37.6	-120.6	-104.5	80.7	68.4
S		35	U.S.A.	2:02:51:00	2:02:57:15	06:15	37.6	36.5	-104.5	-074.5	68.4	47.6
	P	35	Atlantic	2:02:56:45	2:02:59:45	03:00	36.9	33.9	-076.8	-063.3	49.2	40.2
	P	35	Senegal	2:03:10:15	2:03:15:45	05:30	13.4	-00.1	-025.1	-008.7	30.2	43.0

Table 5.1.2-1. Data Acquisition Period for SMIRR and OCE (cont.)

Priority[a] SMIRR	Priority[a] OCE	Orbit No.	Area	MET[b] Start D:HH:MM:SS	MET[b] Stop D:HH:MM:SS	Data period MM:SS	Latitude,[c] deg. Start	Latitude,[c] deg. Stop	Longitude,[d] deg. Start	Longitude,[d] deg. Stop	SEA,[e] deg. Start	SEA,[e] deg. Stop
P		36	U.S.A.	2:04:21:15	2:04:30:30	09:15	37.9	32.0	-123.5	-080.6	65.9	36.9
	P	36	Gulf Stream	2:04:30:30	2:04:33:00	02:30	32.0	27.8	-080.6	-070.7	36.9	31.4
	P	38	Pacific	2:07:29:30	2:07:32:30	03:00	31.8	26.7	-125.8	-114.1	36.9	30.3
	P	38	Guatamala	2:07:37:45	2:07:44:00	06:15	15.4	00.1	-096.2	-077.5	28.1	41.3
S		38	S. America	2:07:43:15	2:07:49:00	05:45	02.0	-12.2	-079.7	-062.7	39.2	57.2
	S	40	Japan-Pacific	2:10:18:30	2:10:21:00	02:30	37.7	38.2	142.7	154.8	69.2	60.5
	P	41	Japan-Pacific	2:11:52:30	2:11:55:30	03:00	37.5	34.9	141.8	155.7	53.8	44.1
S		42	China	2:13:14:45	2:13:24:30	09:45	35.8	35.4	084.7	130.9	79.3	45.7
	P	42	Japan-Pacific	2:13:25:45	2:13:29:15	03:30	34.0	28.5	136.4	150.7	42.0	32.5
S		44	W. Asia	2:16:13:45	2:16:26:15	12:30	35.9	31.7	039.6	097.6	79.7	37.5
P		44	China	2:16:24:00	2:16:26:30	02:30	34.7	31.3	088.0	098.6	44.3	36.9
S		44	E. Asia	2:16:26:30	2:16:31:15	04:45	31.3	22.4	098.6	116.4	36.9	27.0
P		45	Australia	2:18:16:15	2:18:18:00	01:45	-15.0	-19.0	141.1	146.7	58.0	64.0
P		46	Mediterranean	2:19:18:15	2:19:33:00	14:45	38.1	16.0	020.7	080.2	60.3	25.5
P		46	Australia	2:19:46:45	2:19:52:15	05:30	-17.4	-28.8	121.6	140.9	61.1	80.8
P		47	Spain	2:20:46:30	2:20:48:00	01:45	38.2	38.0	-007.9	-000.6	64.9	59.6
	S	47	Spain	2:20:47:45	2:20:50:15	02:30	38.0	36.7	-001.7	010.1	60.5	51.8
P		47	N. Africa	2:20:54:45	2:21:02:00	07:15	31.4	17.0	029.8	055.9	37.5	25.1
	P	48	Atlantic	2:22:19:00	2:22:22:00	03:00	37.2	34.4	-016.0	-002.2	54.5	44.4
S		50	U.S.A.	3:01:11:00	3:01:15:15	04:15	36.5	38.2	-094.5	-074.2	79.7	64.3
	S	50	Atlantic	3:01:16:00	3:01:18:15	02:15	38.1	37.0	-070.6	-059.8	61.7	53.8
P		50	Africa	3:01:29:00	3:01:35:00	06:00	19.9	05.7	-016.8	001.8	25.2	29.8
P		50	Africa	3:01:37:15	3:01:46:00	08:45	00.1	-20.8	008.4	035.2	35.6	64.7

Table 5.1.2-1. Data Acquisition Period for SMIRR and OCE (cont.) 8/25/81

Priority[a] SMIRR	Priority[a] OCE	Orbit No.	Area	MET[b] Start D:HH:MM:SS	MET[b] Stop D:HH:MM:SS	Data period MM:SS	Latitude,[c] deg. Start	Latitude,[c] deg. Stop	Longitude,[d] deg. Start	Longitude,[d] deg. Stop	SEA,[e] deg. Start	SEA,[e] deg. Stop
S		51	U.S.A.	3:02:40:15	3:02:49:30	09:00	36.4	35.3	-118.2	-074.3	80.8	47.9
	P	51	N.C.-Bermuda	3:02:49:15	3:02:52:00	02:45	35.6	32.1	-075.4	-063.5	48.7	39.8
P		52	U.S.A.	3:04:13:15	3:04:22:45	09:30	38.1	30.0	-124.1	-081.0	68.1	36.0
	P	52	Atlantic	3:04:22:30	3:04:24:45	02:15	30.4	26.4	-082.0	-073.4	36.7	30.6
	S	53	Pacific	3:05:45:00	3:05:48:00	03:00	37.8	35.7	-135.7	-121.6	60.2	49.7
P		53	U.S.A.	3:05:48:00	3:05:54:00	06:00	35.7	26.7	-121.6	-096.9	49.7	31.2
	P	54	Pacific	3:07:32:15	3:07:35:15	03:00	06.8	-00.6	-091.0	-082.2	27.1	34.5
P		54	S. America-Peru	3:07:35:30	3:07:46:15	10:45	-01.2	-26.1	-081.5	-047.3	25.3	72.0
	S	57	Japan-Pacific	3:11:43:00	3:11:46:30	03:30	37.7	34.9	134.3	150.5	60.5	48.1
	P	58	Strait of Korea	3:13:16:15	3:13:20:15	04:00	34.5	28.4	129.1	145.5	47.3	34.3
S		59	SE Asia	3:14:36:45	3:14:49:30	12:45	37.2	28.7	064.2	122.0	80.0	35.0
P		61	Australia	3:18:05:30	3:18:12:30	07:00	-11.1	-26.6	130.5	153.8	44.7	69.9
P		63	Spain	3:20:38:15	3:20:40:00	01:45	38.1	37.5	-009.0	-000.6	67.3	60.9
	P	63	Mediterranean	3:20:40:00	3:20:42:00	02:00	37.5	36.0	-000.6	008.7	60.9	53.6
P		63	Arabia	3:20:44:30	3:20:53:30	09:00	33.0	15.5	019.7	052.5	44.8	21.5
	S	64	Atlantic	3:22:10:45	3:22:13:00	02:15	36.6	34.2	-017.2	-007.1	56.4	48.3
S		65	Africa	3:23:49:00	4:00:04:00	15:00	22.9	-13.0	-004.2	041.6	27.5	45.6
	S	66	Atlantic	4:01:07:00	4:01:11:15	04:15	38.0	34.9	-075.2	-055.4	66.6	51.0
P		67	U.S.A.	4:02:32:45	4:02:40:45	08:00	37.5	34.8	-115.8	-077.9	80.8	51.1
	P	67	N.C.-Bermuda	4:02:40:45	4:02:44:15	03:30	34.8	29.8	-077.9	-063.2	51.1	38.8
	P	67	Atlantic	4:03:05:45	4:03:08:30	02:45	-19.8	-25.5	005.2	014.7	55.1	65.3
P		67	S. Africa	4:03:08:30	4:03:12:15	03:45	-25.5	-32.1	-014.7	029.3	65.3	79.3
	P	69	Pacific	4:05:37:45	4:05:40:15	02:30	36.7	34.0	-131.9	-120.6	58.4	49.3

Table 5.1.2-1. Data Acquisition Period for SMIRR and OCE (cont.) 8/25/81

Priority[a] SMIRR	Priority[a] OCE	Orbit No.	Area	MET[b] Start D:HH:MM:SS	MET[b] Stop D:HH:MM:SS	Data period MM:SS	Latitude,[c] deg. Start	Latitude,[c] deg. Stop	Longitude,[d] deg. Start	Longitude,[d] deg. Stop	SEA,[e] deg. Start	SEA,[e] deg. Stop
	P	70	Pacific-Peru	4:07:24:00	4:07:28:15	04:15	04.4	-06.1	-093.6	-081.2	22.1	33.6
S		79	Middle East	4:20:29:45	4:20:44:45	15:00	37.9	14.1	-010.5	048.9	70.0	19.0

SMIRR Data Acquisition period totals: Primary (P) TIME 305:00
Secondary (S) TIME 202:00

OCE Data Acquisition period totals: Primary (P) TIME 119:15
Secondary (S) TIME 39.15

For September 30, 1981 Launch

[a]Priority: P = Primary area; S = Secondary area.
[b]MET = Mission Elapse Time.
[c]Latitude prefix (-) is for South, no prefix is North
[d]Longitude prefix (-) is for West, no prefix is East
[e]SEA = Sun Elevation Angle.

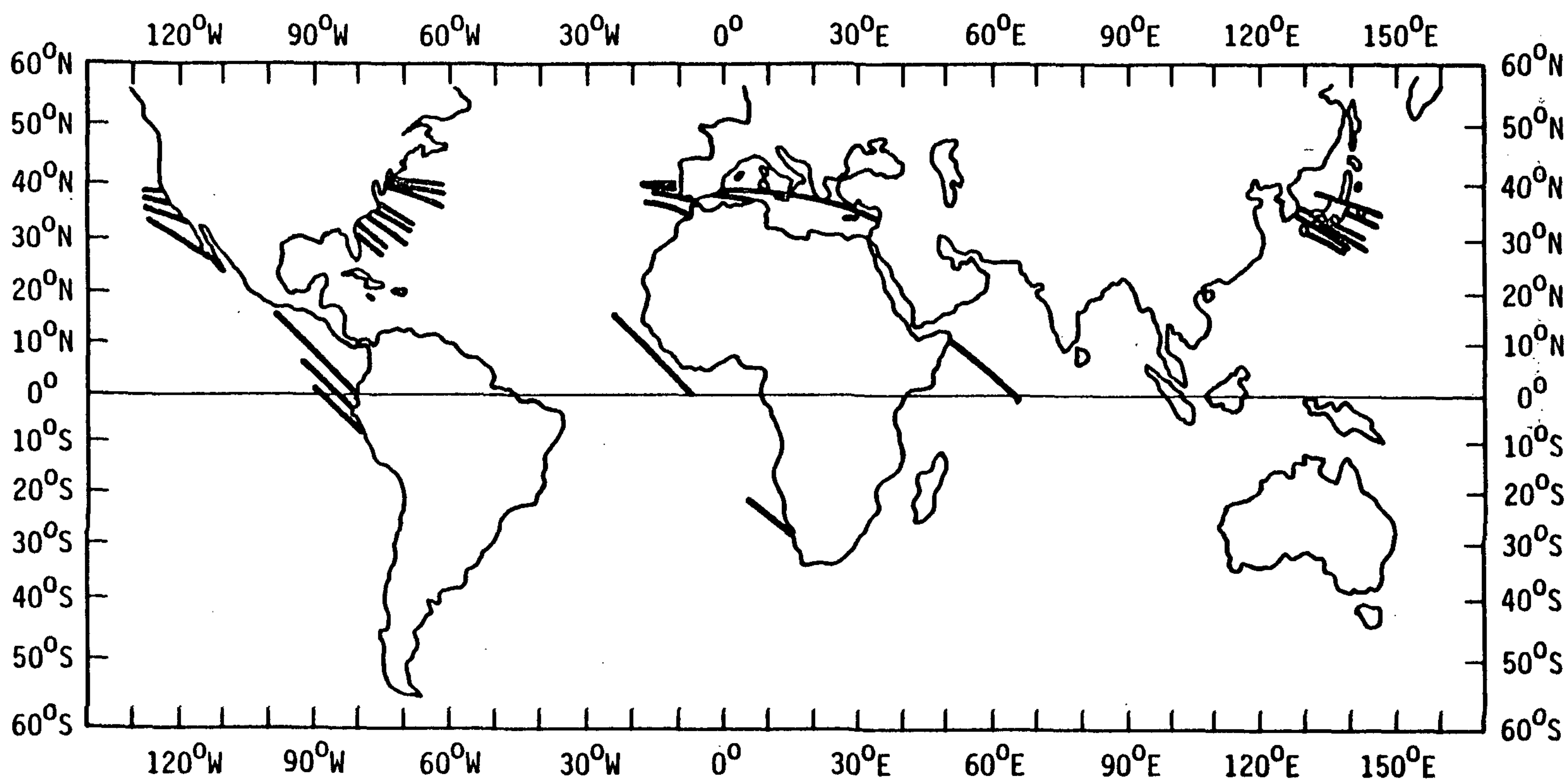


Figure 5.1.5-1. OCE Primary Coverage Pattern

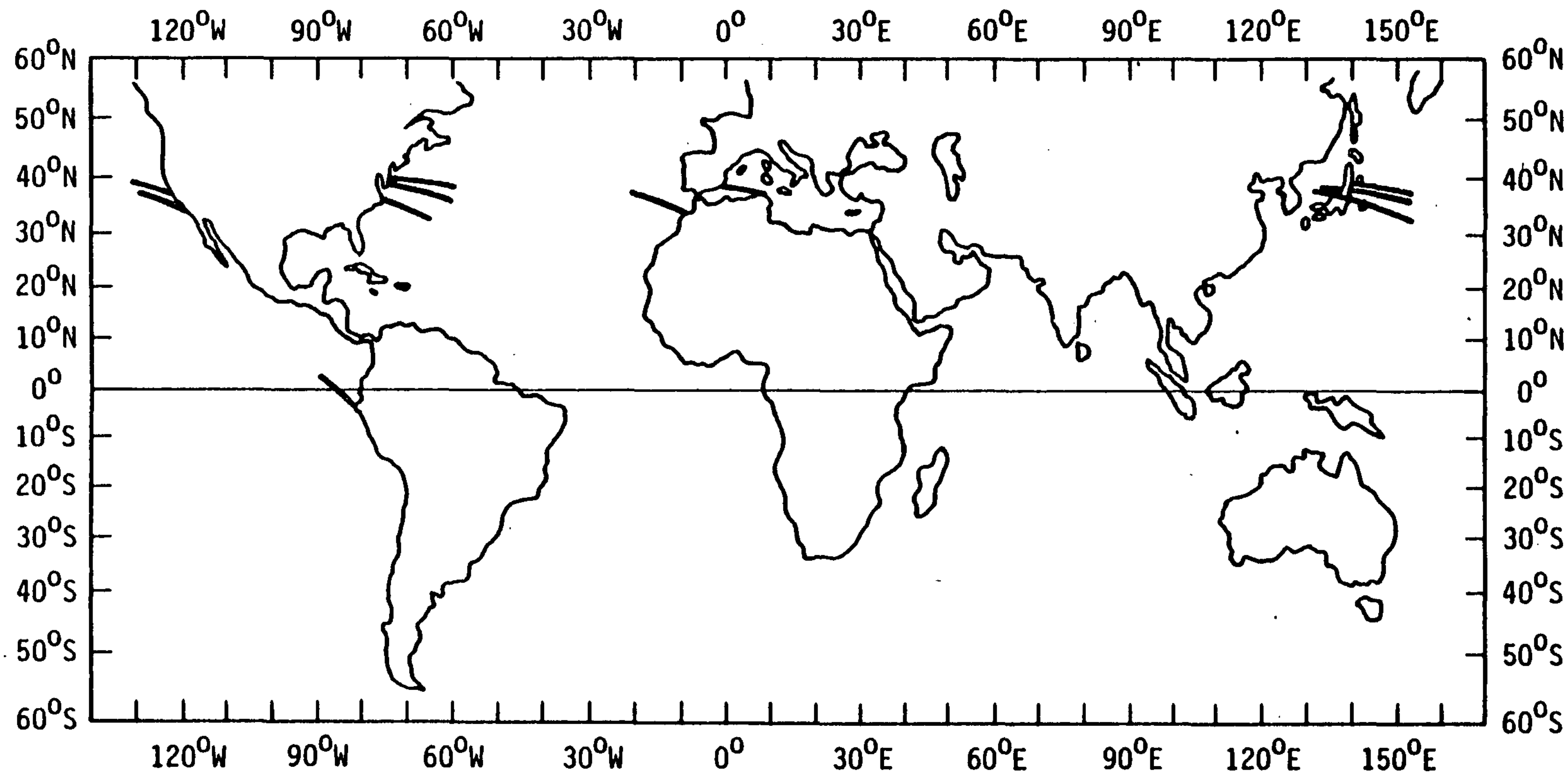


Figure 5.1.5-2. OCE Secondary Coverage Pattern

weather conditions occur at the designated sites, repeated coverage of each designated area is planned as shown in the figures. An example showing the OCE coverage of the areas across the Kuroshio and Tushima Current is given in Figure 5.1.5-3.

5.2 EFFECT OF CHANGES IN FLIGHT OPERATIONS

5.2.1 SIR-A

The orbital parameters which are critical to the SIR-A experiment are, in priority:

a. Low ellipticity
b. Shuttle attitude
c. Altitude of 150 n. mile with error of $\pm$ 2 n. miles
d. Orbital maneuvers timing
e. Inclination

The low ellipticity is essential to be able to process the data nominally. Larger orbital ellipticity will lead to additional doppler shift which can only be partially accounted for. This will lead to a degradation in the image quality. The limit on ellipticity is less than 0.0002.

The Shuttle attitude is important for the proper setting of the sensitivity time control (STC). It is essential that the following requirements are met:

a. Antenna pointing angle is $47^{o} \pm 2^{o}$ from vertical.
b. Pointing angle drift rate is less than 0.05^{o}/sec.

The Shuttle altitude determines the set-up of the pulse repetition frequency (PRF), STC and receiver gain. It also determines the on-off sequence. The SIR-A sensor can nominally accommodate all altitudes between 125 nautical miles and 160 nautical miles, however the sequence which will be loaded in the sequencer corresponds to the nominal altitude. Any variation in the altitude requires MET updates and commands for proper operations. The details are provided in the "SIR-A Mission Operations Procedures Handbook".

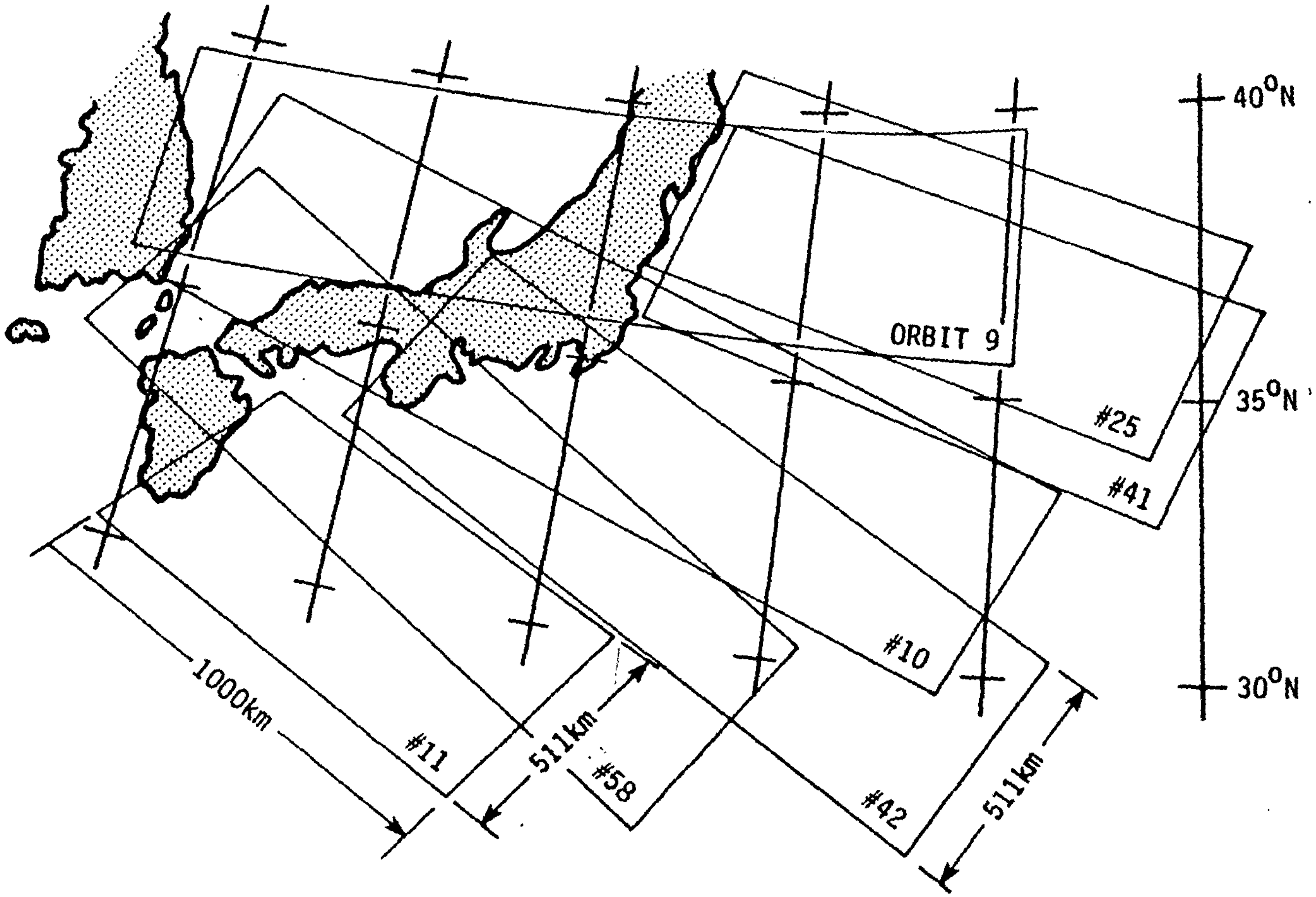


Figure 5.1.5-3. OCE Coverage of the Areas across the Kuroshio and Tushima Current

Small changes in orbital inclination will require updating the MET to make sure proper coverage is achieved. This will lead to a slightly different spatial coverage; however, this is not critical to the success of the experiment.

5.2.2 SMIRR

The major requirement for SMIRR is that a relatively high inclination be chosen for the mission, such as the 38.5° inclination chosen for the OSTA-1 flight. The data quality is not affected by a change in altitude of $\pm$ 50 km and variations in attitude within the nominal values. Changes in altitude affect the ground IFOV and variations in attitude are recorded by the cameras.

5.2.3 FILE

Orbiter flight attitudes can affect the data acquisition plan of FILE. Launch slippage to winter will result in poor lighting and snow cover, both negative impacts.

5.2.4 MAPS

Since the atmosphere is a dynamic system that is global in nature, it is important for the MAPS experiment to survey the entire subsatellite area as thoroughly as possible. In order to carry this out, it is planned that the experiment will be turned on as early as possible during the flight and will remain on as long as possible while the bay doors are open. If the instrument is turned off for any reason, approximately 1 hour of data is lost while the instrument warms up and is recalibrated. The instrument will not be damaged by short periods of direct solar viewing (the roll rate should be greater than 0.2 deg./sec. while rolling the field of view through the Sun). However, under normal conditions, if the instrument is turned off, the mirror should be placed in the "STOWED" position.

5.2.5 OCE

The following changes in flight operations will influence the OCE's data acquisition capability: 1) any Shuttle maneuver which causes the

spacecraft to go out of the ZLV mode will prevent OCE measurements; 2) all data-taking presupposes a 280-km altitude for the platform; during the OMS-3 to OMS-4 or -5 maneuvers, data taking will be precluded; 3) during RMS maneuvers, data acquisition will be interrupted when the mechanical arm blocks the field-of-view.

5.3 CONSTRAINTS DURING DATA COLLECTION

5.3.1 SIR-A

During the SIR-A sensor operations, the following constraints must be met:

a. No water dumps
b. The RMS arm cannot be on the same side of the Shuttle as the SIR-A antenna during data collection.

5.3.2 SMMIR

The constraints of SMIRR data acquisition are

a. $\pm 80^{\circ}$ sun angle
b. ZLV orientation
c. No data acquisition within 10 minutes of a water dump.

5.3.3 FILE

The experiment operates automatically after initial crew activation. There are no scheduled crew activities.

5.3.4 MAPS

The MAPS experiment is not particularly sensitive to orbital parameters. The inclination affects the latitude belt covered and the altitude affects the size of the instantaneous field of view, but the variations likely to be encountered on the STS-2 mission should have only minor impact on the experiment. In the interest of simplicity in the data reduction, it is desirable that the vehicle Z-axis be aligned to local vertical within 5°; however, known misalignments of up to 20° could be handled by the use of somewhat more complex data reduction techniques.

5.3.5 OCE

The OCE is particularly sensitive to orbital parameters. Several major constraints that will limit data acquisition during the flight are cloud cover of target areas, direct sun-glint from the sea surface into the sensor and the Orbiter's altitude and attitude. Orbits have been selected with solar zenith angle in the range of 30^{o} to 60^{o}. Changes in altitudes effect the ground resolution.

The OCE data-taking should be aborted if unscheduled Orbiter effluent discharge occurs. The salient instrumental feature of the OCE is a fully rotating scanner mirror with a dielectric coating on the surface. This mirror is extremely susceptible to contaminants such as water vapor or other degassing chemicals. Whenever this happens, the scanner hatch door should be securely closed and data-taking should be postponed.

5.3.6 NOSL

During the NOSL operations, the constraints are: Modulated light from lights or CRT must not be allowed to reach photocell detector during data taking. Reflected light from surface of windows may interfere with photography particularly during daylight operations.

5.4 IMPACT OF CHANGES IN DATA ACQUISITION PLANS

5.4.1 SIR-A

Changes in the data acquisition plan will have impact on the SIR-A operations. Any change in the data acqusition plan will most likely require changes to all or some of the following SIR-A parameters: turn on time, turn off time, STC location, PRF and receiver gain.

5.4.2 SMIRR

The investigators understand a need for flexibility in data acquisition to accommodate mission requirements. Since the data acquired are of an exploratory nature and no specific test site is being sought, other than the western U.S. region, changes in data acquisition plans do not strongly affect the success of the experiment. However, significant reduction in

the time allotted to the experiment will reduce the value of the statistical sample of reflectance data acquired on a worldwide basis.

5.4.3 FILE

The experiment is designed to obtain data over a statistically significant mix of the major Earth Features, which can be expected from a typical Shuttle mission, provided sufficient ZLV time and sun angle of 40^{0} or greater (from horizon) is available and the Shuttle orientation is not changed frequently. Significant reduction in ZLV time can reduce the value of the statistical sample of reflectance data acquired on a worldwide basis. Out-of-ZLV maneuvers or other attitude changes of Shuttle on the daylight side can cause loss of data--loss greater than would be represented by a linear proportionality to time out-of-ZLV.

5.4.4 MAPS

Any loss of viewing time for this experiment results in a loss of data. Such losses are particularly important on the second and third days of the mission since there is some overlap in the ground coverage of days one and four.

5.4.5 OCE

Real-time coverage of target areas via weather satellite images is being set up at POCC so that the investigators at POCC can advise the mission manager of cloud coverage in the test areas and assist in making go/no-go decisions concerning changes in the data acquisition plan.

The OCE will focus on the preselected test areas where in-situ activities are planned. In order to maximize the probability of successful collection of data in the event that adverse weather conditions occur at the designated sites, repeated coverage of each designated area is planned.

5.4.6 NOSL

Changes in the data acquisition plans generated either by the astronauts or at POCC should have minimal impact due to flexibility of operation.

5.5 USE OF ORBITER DATA RESOURCES

5.5.1 SIR-A

No use of Orbiter data resources is required.

5.5.2 SMIRR

SMIRR data are stored on the flight payload recorder. The present flight plan calls for approximately 5 hours of data acquisition from the radiometer. The film cameras have a capacity for 6 hours of data taking.

The recorder is shared with OCE. SMIRR has been allotted 315 minutes of recorder time at 6 in/sec.

The crew command capability is used whenever available. However, SMIRR is completely autonomous through use of ground commands, stored program commands and the instrument sequencer.

5.5.3 FILE

There is no requirement for use of Orbiter data resources.

5.5.4 MAPS

The instrument contains its own single reel digital tape recorder. No reel replacement is required during the flight, and no data is transmitted to POCC. The payload crew operation consists of turning the experiment on to enable the instrumentation to warmup prior to data acquisition, and of turning the switch off at the completion of the experiment.

5.5.5 OCE

The OCE will use the Orbiter's payload tape recorder to record eight channels of spectro-radiometric data collected during the mission. The tape recorder will be time-shared by OCE and the Shuttle Multispectral Infrared Radiometer (SMIRR) experiment. This alternate use is feasible because SMIRR will take data only over land and OCE only over oceans during sunlit passes. For the OCE, approximately 120 minutes of recording time is allocated. In order to accommodate the OCE 307.2 kbps biphase data rate,

the Orbiter payload tape recorder will be operated at a speed of 38 inches per second. Even though data will be limited to 120 minutes ($2x10^9$ bits), this period is equivalent to roughly 5×10^4 km. in linear distance, with the Scanner's swath width of 511 km.

OCE is a preprogrammed experiment with crew command control optional.

SECTION 6. PAYLOAD OPERATIONS CONTROL CENTER

SECTION 6. PAYLOAD OPERATIONS CONTROL CENTER

The Payload Operations Control Center (POCC) at JSC is designed to perform the ground operations for the Shuttle flights. Therefore, the OSTA-1 operations shall be conducted from the POCC. All payload real-time operations commands and timeline changes will originate from within the POCC and provide interfaces to the Mission Control Center (MCC) with the intent of optimizing the payload science return. The POCC staffing will include the Program Scientist and Program Manager for OSTA-1 from NASA Headquarters, and the POCC Director and his POCC team, consisting of Mission Scientist, Science Planning, Experiment Systems Support, Principle Investigators, and Payload Command.

The interfaces between the Space Transportation System (STS) team in the MCC and the OSTA-1 team in the POCC are shown in Figure 6.0-1. The services required, command and control, and operation and real-time decision for the operation of experiments at the POCC are summarized in Table 6.0-1. The requirements of each experiment on the POCC are described in the following subsections.

6.1 SERVICES REQUIRED FOR MISSION

6.1.1 SIR-A

The services required for the SIR-A at the POCC can be divided into the following categories:

a. Mission activities update - The status of IMU, water dump, payload door activity, RMS activity and non-planned attitude change (from ZLV) are required to be reported to the SIR-A experiment team.

b. Orbital element update - The orbital element information such as semi-major axis, eccentricity, inclination, and mean anomaly should be provided.

c. Command and control interface.

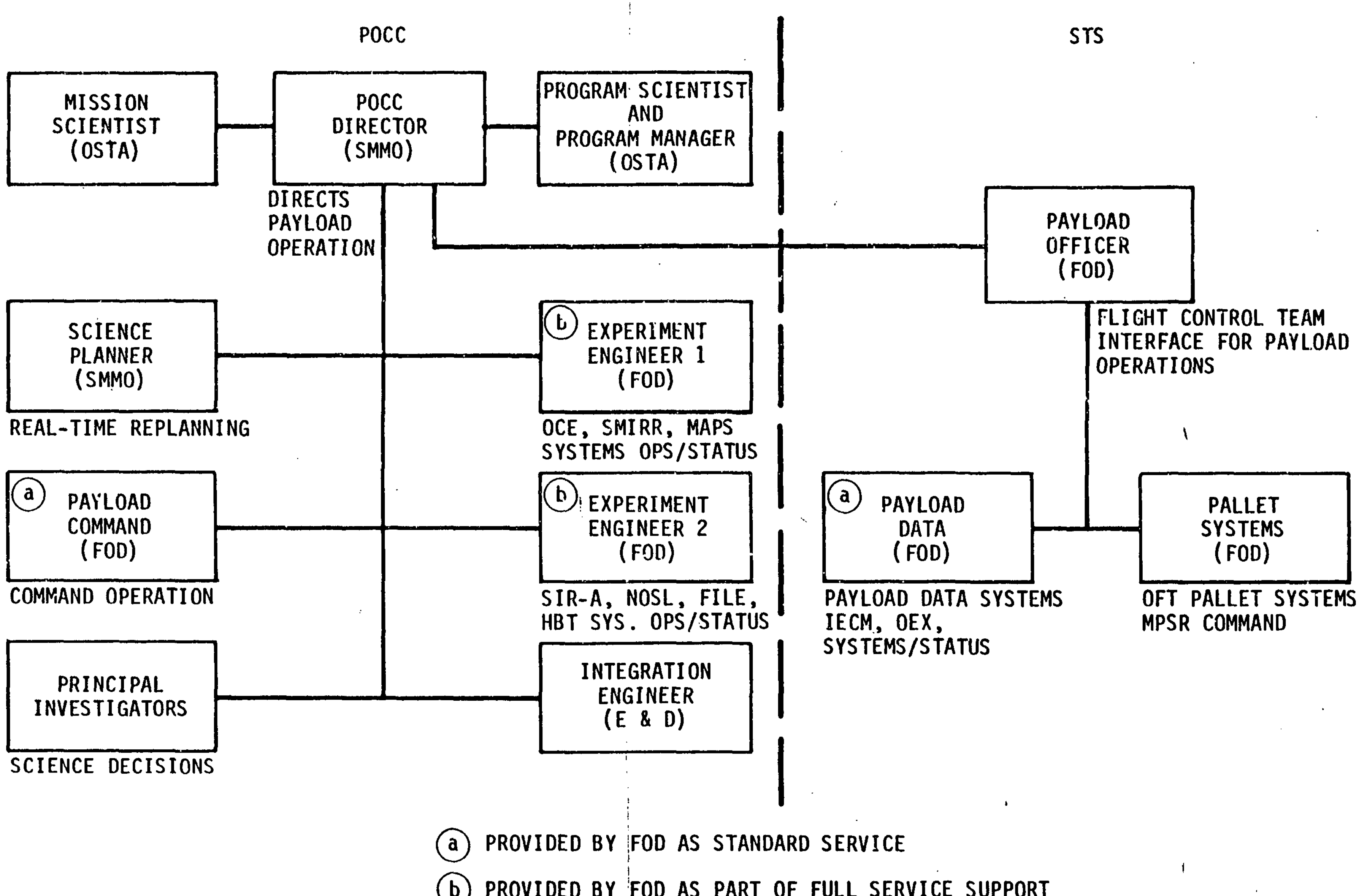


Figure 6.0-1. Payload Operations Structure

Table 6.0-1. OSTA-1 POCC Activities

INSTRUMENT	COMMAND AND CONTROL	OPERATION AND REAL-TIME DECISION	REMARKS
SIR-A	o Crew Command o Stored Program Command	Corrective actions are applied for any anomalous behavior	No scheduled crew activities except for INHIBIT/ENABLE for some RMS OPS
SMIRR	o Crew Command o Stored Program Command	Secondary targets are chosen because of excessive cloud coverage	
MAPS	o Stored Program Command	Rebalance command	
FILE	o Stored Program Command	Optional crew turn-on	
OCE	o Crew Command o Stored Program Command	Secondary targets are chosen for excessive cloud coverage	
NOSL	N/A	Target of opportunity experiment	
HBT	N/A	N/A	

d. Instrument swaths hardcopy.

e. Engineering telemetry update.

f. Payload command control.

6.1.2 SMIRR

During the OSTA-1 mission, the principal investigator and his representatives will require, in addition to the services available at the experiment's console, (1) a dedicated telephone to make and receive long distance calls, and (2) weather information for prediction of large storm systems with clouds covering large areas. Real time display of the instrument commands and status bits (see Table 6.1-1) is required whenever the instrument is operating.

Table 6.1-1. SMIRR Commands and Status

SMIRR Status Bits	SMIRR COMMANDS
Filter Wheel and Lock	Power: On/Off
Detector Temperature	Cover: Open/Close
Camera Housing Pressure	Camera Mode: Operate/Stand By
Calibrate Status	Calibration Lamps: On/Off
Cover Open	
Cover Closed	
Camera Mode	
Camera Status	

6.1.3 FILE

Instrument activation must be verified during the dark side of a ZLV orbit. Once activated, the instrument is totally autonomous.

6.1.4 MAPS

The pre-launch service required is precalibration of the infrared film. During the mission, the Principal Investigator and his representatives will require coolant loop temperatures, times of effluent discharges, weather analyses indicating probable cloud cover over STS-2 ground track for the purpose of coordinating correlative underflights.

Post-mission services required are processing and sensiometric calibration of infrared film, ephemeris data (ground track latitude and longitude, altitude and attitude as a function of time), and launch and landing vibration levels. Laboratory and dark-room facilities will be required at DFRC for data strip-out and film removal.

6.1.5 OCE

The services required for OCE operation at the POCC can be divided into the following three categories:

a. Mission Activities Update - The status of the IMU, water dump, data taking activities of SMIRR, and the performance of the payload tape recorder.

b. Engineering Telemetry Update - The team requires the following housekeeping telemetry display whenever the Orbiter's downlink is possible. There are 8 discrete (I/O) status channels and 5 analog channels as follows:

Status Indicator	Scanner door open
(Yes or No)	Scanner mirror rotating
	Channel 5 video signal operating
	PCM operating
	PCM sync operating
	DC power present
	Scanner power present
	Scanner AC power present

Analog Signal	Scanner base plate temperature
	Main electronic assembly base plate temperature
	Scanner AC current
	Total current
	Detector box temperature

c. In addition to the above services available at the experiment console, the OCE-POCC team will require:

   (1) A facsimile unit to display cloud coverage of OCE's predetermined target areas.

   (2) A C4 telephone link from Goddard's direct readout station (WEFAX) to POCC.

   (3) Two dedicated telephone links to make and receive long distance calls to field teams. This includes a telephone link to the European field team from POCC which is to be arranged by the DFVLR team, West Germany.

6.2 PAYLOAD COMMAND AND CONTROL

6.2.1 SIR-A

The SIR-A can be controlled in two primary ways: 1) an onboard sequencer can operate the instrument with appropriate ground initiation commands, 2) in all cases, ground commands can be sent to reconfigure the sensor setup and to operate it directly. The SIR-A experiment team will command the radar system by submitting command requests of the following types:

a. Ground to radar system command (real time command)
b. Sequencer initiation commands (real-time command)
c. Stored program commands
d. Shuttle roll request
e. Crew command
f. Payload operations and real-time decisions (This will be described in detail in Section 6.3.1).

6.2.2 SMIRR

The instrument commands are listed in Table 6.1-1. The instrument can be commanded via the console in the crew compartment, stored program commands, or ground commands. The instrument contains a sequencer that can command the instrument if none of the regular command options are available. The sequencer is initiated by a power-on command when the instrument is in the automatic mode.

6.2.3 FILE

There is an Orbiter crew turn-on command option. The instrument is otherwise totally autonomous.

6.2.4 MAPS

MAPS, command power can be turned on or off by means of a ground command or a crew-initiated command through the Pallet Control console on the Orbiter. Periodic rebalance of the instrument occurs either automatically, every 12 hours, or as a result of a rebalance command from the ground at the request of the Principal Investigator.

6.2.5 OCE

The commands of the OCE operation may be performed in the following three modes:

a. Crew Commands
b. Stored Program Commands (SPC)
c. Real-Time Ground Commands (RTC).

For the OCE, no crew operation will be exercised and all the data passes will be performed via SPC or RTC. The reasons are the following:

a. Because the OCE is a self-contained automated scanner system, a single step on and off command will sequence the data-taking.

b. Data-taking will be reviewed at POCC based on real-time cloud cover facsimile display, and go/no-go recommendations will be made at POCC. Thus the crew's participation will not be needed.

c. Whenever possible, each OCE data pass will follow the predetermined schedule with one mode of command (SPC or RTC).

The OCE investigators at POCC will advise the cloud-cover conditions of the upcoming test site to the POCC science planner with sufficient lead time.

6.3 PAYLOAD OPERATIONS AND REAL-TIME DECISIONS

6.3.1 SIR-A

SIR-A engineering data will be received at the POCC during the flight. These data will indicate any anomalous behavior. Corrective actions could then be applied for parameter changes.

6.3.2 SMIRR

SMIRR data are not relayed to the POCC and therefore real-time decisions will be made based on the status information, weather and changes in the flight plan. Two persons will be at the SMIRR station at all times during flight.

Ground commands are used whenever the crew is not available. The sequencer is only used when out of contact with the ground and when stored program command storage is insufficient.

6.3.3 FILE

Use of optional Orbiter crew turn-on command is dependent on time of launch.

6.3.4 MAPS

In normal operation, MAPS command power is turned on or off by the crew as part of the OSTA-1 pallet activation or deactivation. No other actions or tests are required of the crew. In the event of significant pallet coolant loop temperature variations, the Principal Investigator or his

representative may request a ground-commanded rebalance. In addition, requests for rebalance commands may be made in order to cause the rebalance cycle to coincide with non-ZLV maneuvers so as to avoid loss of data during ZLV maneuvers. In order not to exceed the capacity of the MAPS flight recorder, it is anticipated that a request for MAPS command power off will be made during orbit 72. If it appears that significant ZLV opportunities will be available later in the mission, a request for MAPS command power on may be made.

6.3.5 OCE

To minimize data loss, a real-time display of cloud coverage of target areas via weather satellite images at POCC will be available for guidance to changes in the data acqusition plan.

6.3.6 NOSL

The operations and real-time decision of NOSL experiment is entirely dependent upon the weather conditions and proposed mission timelines.

SECTION 7. DATA RECEIVED FROM ORBITER

SECTION 7. DATA RECEIVED FROM ORBITER

After landing of the Shuttle Orbiter at Dryden Flight Research Center, the ground crew will enter and remove film, tapes, cameras, recorders, specimens, etc., as described in the following section. These data media are subsequently delivered to laboratories at DFRC, JSC, or Principal Investigator's facilities, or handed over to representatives of the Principal Investigators. Data on the Orbiter payload tape recorder are played back and recorded. Provisions for handling and transporting these data media are also described in this section for each experiment.

Requirements for ancillary data which are collected onboard the Orbiter, e.g., environmental history data, are also described in this section.

7.1 INITIAL DATA TRANSPORTATION AND STORAGE

7.1.1 SIR-A

Removal of the SIR-A optical recorder take-up film cassette will occur 8 to 72 hours after STS-2 touchdown. A Rockwell International technician has been trained to remove the cassette at DFRC. The complete procedure for take-up cassette removal was documented by JPL. The procedure provides instructions for removing the thermal blanket, releasing locking pins, removing the 19-kg cassette and placing it in its carrying case, installing protective covers on the connectors, taping the loose end of the cut film to the optical recorder and installing a dust cover on the recorder in place of the take-up cassette.

JPL will provide technical support at DFRC during the cassette removal from the SIR-A optical recorder. In order for JPL personnel to be on standby at DFRC during the removal it will be necessary for JSC Mission Manager (G. Kenney) or his designated alternate to alert the SIR-A Principal Investigator (Dr. C. Elachi) or his designated alternate, by telephone at least 24 hours prior to the removal of the film cassette from the SIR-A Optical Recorder.

JPL will provide a custom carrying case for the SIR-A take-up-reel cassette at DFRC. The size of this case is 24 x 24 x 16 inches. JPL will also provide the necessary connector covers, tape and dust covers to prepare the optical recorder for the flight to KSC. The carrying case will be carried into the payload bay prior to SIR-A cassette removal and the film cassette will be placed in this carrying case immediately after removal from the optical recorder. The SIR-A flight film cassette installed in the carrying case will then be handed over to Dr. Charles Elachi or his designated alternate by Jerry Kenney or his designated alternate via a DD1149. The film will then be hand carried to JPL from DFRC and logged into the JPL SIR-A Data Center in Building 183, Room 713 for processing. After logging in at JPL, the film will be unloaded from the cassette in a dark room and 15 feet will be immediately developed and correlated to verify image quality.

When the signal film is first retrieved from the Shuttle, the cannister is not only taped appropriately, but Quality Assurance seals are affixed to the cannister in such a manner that any unauthorized opening will be indicated by the seals being damaged. These seals will be signed and dated. The Radar Photo Lab will not accept responsibility for physical defects or photometric accuracy if these seals are not intact at the time of receipt.

Because of the likelihood that the film preparation procedures will quite possibly take several days, a safe environment will be provided. The prime considerations are:

a. The area selected for storage will be a controlled and secured access area.

b. Environment.

(1) Temperature and humidity.

The storage area is capable of providing both ambient temperature and humidity ranges (i.e. 70^{0}F and 50% relative humidity) and cold storage facilities. For environmental preparation of the signal film prior to processing, the ambient conditions will be employed. For this section, the term "ambient" refers to the

established environment of the signal film processing area. However, should the decision be made not to process the film at that time, then the film will be placed in cold storage. The conditions for cold storage will be determined by the projected estimate of time lag prior to processing.
A rough, temporary guideline will be:

Time lag before processing	Conditions
less than 1 week	$33^{o}F$ - $45^{o}F$
1 week	$32^{o}F$

In either case of cold storage, the film will be enclosed in a moisture-proof bag to preclude adverse humidity conditions from interacting with the latent image. In the case of cold storage for less than a week, the temperature range greater than freezing has been purposely chosen to facilitate easier environmental seasoning.

(2) Light Conditions.

Since the film will be unprocessed, strict darkroom conditions meeting the requirements specified by Eastman Kodak for 3493 film will be adhered to. In addition, the integrity of the darkroom conditions will be tested with raw film prior to actual storage.

7.1.2 SMIRR

The film magazines will be removed from the SMIRR instrument according to Rockwell International Operations Maintenance Instructions. The Rockwell person responsible for removing the film magazines is Charles Crawford, Mechanical Systems Engineer. The film removal procedure is listed step by step as follows:

1. Clip thermal blanket lacing cord around camera housing and remove cord.

2. Gently lower MLI flap.

3. Unscrew the pressure release bolt until the pressure equalizes; retighten the bolt.

4. Unbolt the 20 bolts around the camera housing.

5. Remove camera housing cover.

6. Release catch on film magazine and remove film magazines.

7. Replace camera housing cover and tighten the bolts.

8. Replace the MLI flap.

9. Remove film magazines from Payload bay.

The magazines will be received by a representative of the JSC mission manager and will be flown direclty to JSC, and hand carried to the JSC photo lab. It is required to keep the film magazines refrigerated or frozen except when they are being transported. During transport, surrounding temperature must be under $80^{o}F$. Noel Lamar is responsible for processing the film magazines at the JSC photo lab. Each film magazine weighs eight pounds and is 9-3/4 x 7-1/4 x 2-3/4 inches in size.

The payload recorder will be played back over telemetry link to the Buckhorn Station, where the data is recorded on analog tapes. These tapes will be delivered to Kennedy Space Center for conversion to computer-compatible tapes (CCTs). Charles Klein is responsible for this conversion at KSC. Transportation, environmental protection, and security provisions for the film and analog tapes are the resonsibility of the JSC mission manager.

The SMIRR analog data is serial and is divided into 5760-bit frames, each beginning with a 32-bit pseudo-random noise (PN) word. This word is AB52D357 (HEX) and should be the sync word for the decommutator. The formatting and documentation requirements for the conversion to digital CCTs are listed below:

a. CCTs will be unlabeled, 1600 bits/inch, 9-track tapes.

b. The SMIRR data will be organized in chronological order on each tape and from reel to reel.

c. Each group of 5760 bits, headed by the PN word, will constitute a tape record.

d. When a break in data occurs due to the end of a data-take period or due to changing tracks or direction on the payload recorder, a file mark will be written to separate that data from the next set of data.

e. Each tape will have a double end-of-file at the end of the data on each tape.

f. The tapes shall be utilized efficiently so a minimum number of tapes are received.

g. If data is lost due to playing back the recorder in only one direction, CCTs shall be generated for playback in both directions. Playback in the forward direction is preferred.

h. No more than four PN (sync) words at the beginning of a data-take period shall be required for the decom to lock onto SMIRR data. If loss of sync occurs, recovery shall occur in no more than two PN words.

i. Each reel should be clearly labeled so it can be identified and compared with supporting documentation.

j. Supporting documentation should include the following:

   (1) File identification and event time at beginning and ending of each file; and

   (2) Explanation of breaks in data (i.e., payload recorder track change, loss of sync, etc.) that are not due to the separate data take periods.

Table 7.1.2-1. Format of Rev. #1 of Minor Frame 0

BITS	DESCRIPTION	
32	PN Word: AB52D357 (HEX)	
	Status	
	Filter Wheel in Lock	OK=1
	Detector Temperature Status	OK=1
	Camera Housing Pressure	OK=1
	Camera Status	OK-1
	Calibrate Status	ON=1
	Cover Open	YES=1
	Cover Closed	YES=1
	Mode	OPERATE=1, STANDBY=0
8	Rev. Counter	
	Rev. Count (0)	3 bits
	Unused (=0)	5 bits
24	Time Code - Least Significant Digits	
	0.01 sec. (<9)	4 bits
	0.1 sec. (<9)	4 bits
	sec. (<9)	4 bits
	ten sec. (<5)	4 bits
	min. (<9)	4 bits
	ten min. (<5)	
24	Time Code - Host Significnat Digits	
	hours (<9)	4 bits
	ten hours (<2)	4 bits
	days (<9)	4 bits
	ten days (<9)	4 bits
	Unused (=0)	8 bits
24	Engineering Data - 1	
	Electronics Temperature	8 bits
	Detector Temperature	8 bits
	Filter Wheel Temperature	8 bits

Table 7.1.2-1. Format of Rev. #1 of Minor Frame 0 (cont.)

BITS	DESCRIPTION	
	Engineering Data - 2	
	Calibration Lamp Volts	8 bits
	Calibration Lamp Current	8 bits
	Power Supplies	8 bits
24	engineering Data - 3	
	+10 V	8 bits
	Camera Housing Pressure	8 bits
	Unused	8 bits
24	Inverter Power	
	Inverter "A" Frequency	8 bits
	Inverter "B" Frequency	8 bits
	Unused (=0)	8 bits
24	Science Data - Filter 6	
24	Science Data - Filter 7	
24	Science Data - Dark 7-8	
24	Science Data - Filter 8	
24	Science Data - Filter 9	
24	Science Data - Dark 9-10	
24	Science Data - Filter 10	

Table 7.1.2-2. Format of Rev. #1 of Minor Frame 1-7

BITS	DESCRIPTION	
32	PN word: AB52D357	
8	Status (same format as in minor frame 0)	
8	Rev. Counter	
	Rev. Counter (1-7)	3 bits
	Spare (=0)	5 bits
312	Science Data	
	Beginning with Filter 2	

k. CCTs and supporting documentation shall be delivered to the SMIRR Principal investigator or his representative one week after the Orbiter lands.

The SMIRR data format is given in Table 7.1.2-1 and -2.

Terms which describe SMIRR data are defined as follows.

Cycle: 1.28 seconds of data; 128 revolutions of the filter wheel; 8 minor frames; 46032 bits. All of the engineering data is contained in the first revolution of each cycle (minor frame 0).

Minor Frame: 0.16 seconds of data; 16 revolutions of the filter wheel; 5760 bits. Only the status bits, rev. counter, and PN word are contained in the first revolution of minor frame 1 - 7.

Rev. Counter: The term used to define the bits which identify the minor frame number. This term is ambiguous because it is really the minor frame counter.

Revolution: One revolution of the filter wheel; 0.010 seconds; 360 bits.

After the film is processed at JSC and the CCTs are generated at KSC, the mission manager will arrange for delivery of these items to the Principal Investigator. The data are expected to be delivered to the P.I. within one week of the Orbiter landing.

Flight data will be hand-carried to JSC and KSC. CCT's and processed films will be shipped to the Principle Investigator by air freight.

7.1.3 FILE

The FILE tape recorder and film camera will be removed at the landing site, the Dryden Flight Research Center (DFRC) by personnel designated by the Johnson Space Center. The tape recorder will be given directly to experiment Investigators from NASA Langeley Research Center (LaRC) and Martin Marietta Aerospace Corporation (MMA, Denver) who will personally transport the tape recorder to MMA, Denver. At MMA, the FILE tape recorder data will

be processed to produce 4 copies of 9-track computer tapes of the FILE data. Two tapes remain at MMA and 2 tapes plus the FILE recorder will be transported by the Investigator to LaRC. The CCT's will then be analyzed both at LaRC and at MMA. The tape recorder, containing the original FILE data, will be held at LaRC (with no recorder erasure) until the major data processing is complete. The tape recorder will eventually be returned to MMA to be reinstalled onto the FILE experiment.

The film magazine will be removed from the FILE camera and will be taken by JSC personnel (or JSC representative) to JSC, where the film will be processed, duplicated, and printed. After film removal, the camera magazine will be sent to MMA. The FILE film camera (minus film magazine) will be taken by the FILE Investigators to MMA for temporary storage. The FILE experiment will later be shipped from KSC to MMA.

Appropriate shipping (carrying) cartons for the 70-mm camera, and tape recorder will be provided at DFRC by the LaRC experiment Investigator. The pertinent physical parameters, for packaging/carrying purposes are follows:

Unit	Weight	Size
Camera	2.7 kg (5.95 lbs.)	0.15 x 0.10 x 0.12m
Tape Recorder	2.8 kg (6.17 lbs.)	0.22 x 0.16 x 0.13m

7.1.4 MAPS

After Orbiter touchdown, at a time to be specified by the JSC OSTA-1 Mission Manager, the MAPS tape recorder and camera package will be removed from the MAPS base plate. Two Rockwell International technicians have been trained to remove these items in accordance with procedures MAPS/OSTA-1-003 ("CAMERA PACKAGE INSTALLATION/REMOVAL") and MAPS/OSTA-1006 ("TAPE RECORDER REMOVAL").

The removal and details of the transport of the tape recorder and camera package to DFRC lab space are the responsibility of the JSC OSTA-1 Mission Manager. Immediately following removal of the tape recorder and camera

package, they will be transported by vehicle to laboratory space at DFRC and transferred to the Principal Investigator or his representative.

Darkroom facilities will be required in which to remove the film from the camera package. Removal of the film from the camera is the responsibility of LaRC personnel designated by the MAPS/OSTA-1 Principal Investigator. After removal of the film from the camera, described in MAPS/OSTA-1-004 ("FILM INSTALLATION/REMOVAL"), the film will be placed in a LaRC supplied light-tight 35-mm film can, sealed with black photographic tape and delivered to personnel designated by the JSC OSTA-1 Mission Manager for transport to JSC and post-flight sensiometric calibration and processing. The data medium is one 550-ft. role of 35-mm false color infrared film type Kodak 2443 aerochrome. The film is wound on a reel approximately 6 inches in diameter. Six copies of the film will be made. All copies will be provided to the Principal Investigator or his representative at LaRC. Copies will then be distributed to individuals by the Principal Investigator.

The strip-out and dumping of the tape recorder is the responsibility of LaRC personnel designated by the MAPS/OSTA-1 Principal Investigator, and will be performed according to Procedure MAPS-OSTA-1-005 ("TAPE RECORDER STRIP-OUT/REWIND").

This procedure requires the use of the LaRC-furnished MAPS Test Set and the Kennedy Incremental recorder, to be located in DFRC-furnished lab space. The environmental controls required during this procedure are temperature, humidity, cleanliness and power suitable for normal data processing. The data medium is a 2400-foot x 1/2-inch 9-track magnetic tape to be furnished by LaRC. Three copies of the flight tape will be made. These tapes will be transported in containers approximately 10 x 10 x 1 inches and weighing approximately 5 lbs. One tape will be hand carried to LaRC by the Principal Investigator or his designated representative. A second copy will be shipped to LaRC via Federal Express and a third copy via United Parcel Service. At LaRC, the tape will be stored in Bldg. 1268 in the tape storage facilities operated by the Analysis and Computation division.

All transfer of film and magnetic tape between organizations will be by means of Form DD 1149.

The time required for removal of the tape recorder and camera package from the STS-2 is estimated to be about 3 hours. The transit time is unknown since it depends on the location of the lab space relative to the landing site. The total time required for film removal and data tape strip-out and copying is approximately 3 hours.

In the event that the tape recorder and camera cannot be removed from STS-2 at DFRC, they will remain attached to the MAPS/OSTA-1 base plate and returned to KSC as part of the payload pallet and removed there. If the tape recorder is removed from the base plate bus and cannot be stripped out at DFRC, it will be hand-carried by LaRC personnel to KSC and stripped out there, following shipment of the MAPS Test Set and the Kennedy Incremental Tape Recorder.

7.1.5 OCE

The flight 8-channel spectral radiance data in PCM format will be transferred from the Orbiter's payload tape recorder upon landing at the Dryden Flight Research Center. This PCM data dump will be done one track at a time sequentially over the fourteen tracks of payload tape recorder. As a precautionary measure, the dump will be repeated to create two sets of duplicate tapes. One of the sets will be processed by KSC as prescribed in the OSTA-1 mission directives. The other set of data tapes will be made available to the OCE team at DFRC. This data set will be hand carried by an OCE project engineer to KSC (or GSFC) where the OCE ground support equipment will be located. The purpose of the OCE use of the data dump is to perform an immediate engineering review of the instrument operation and a preliminary scientific data quality check.

Dave Klein of GSFC, an OCE project engineer will oversee the DFRC payload recorder dump and will hand carry the duplicate tape to KSC flying on a commercial airplane. At DFRC, the OCE project engineer will have the responsibility of verifying the quality and proper waveform of the OCE PCM data signal during the payload recorder dump as well as verifying the

quality of the signal on the duplicate dump tape. These procedures will be performed under the supervision of KSC mission personnel.

The time required for these procedures will depend on the facilities at DFRC. The actual payload recorder dump in both the reverse and forward directions will take approximately one hour with the total procedure to make two dumps taking two to five hours.

The duplicate data will be contained on 4 to 6 reels of one inch by 9200 feet tape of 14 inch diameter. The packaged tape reels will each be in a metal container approximately 1.5 inches high by 16 inches in diameter, weighing about 15 pounds. The tapes will be transported either in the cabin or temperature-controlled cargo bay of the airplane from DFRC to KSC and need to be protected from stray magnetic fields and to be maintained at temperatures in the range of 40°F to 100°F. Humidity must be controlled to prevent condensation. For safety, the OCE tape package should not be located adjacent to the tape package going to KSC personnel.

Receipt and documentation procedures will be controlled by the KSC mission office with delivery of the actual tape from DFRC to the KSC mission representative to the OCE team member. Upon delivery of the tape package to the OCE team member at DFRC, delivery and processing of the OCE tape will be the responsibility of OCE personnel. Contingency plans will cover possible delivery of the OCE tape package by KSC mission personnel to OCE personnel at KSC. The tape package will become the property of the OCE personnel and will be held in storage for one year for emergency use by the KSC mission office.

7.1.6 NOSL

At the DFRC, the magazine remaining in the camera and the tape cassette from the Sony tape recorder will be removed by the JSC personnel. The 13 DAC magazines in the locker drawer plus the 6 magazines in the storage pouch in addition to the one tape cassette in the storage pouch will also be removed. The JSC project office will be responsible for removing the film magazines and tape cassettes. The size of the film magazines

container is 5 x 4 x 1 inches and it weighs 7 lb. The size of tape cassettes container is 3/8 x 2 x 4 inches and it weighs 2 oz.

The time required for removing the contents of the locker is about 5 minutes. Transportation, environmental protection, and security provision for the film magazines and tape cassettes are the responsibility of the JSC mission manager.

7.1.7 HBT

The case containing the HBT will be removed at Dryden Flight Research Center by the DFRC ground crew within one hour after touchdown and will be turned over to the Principal Investigator via the Mission Manager. The temperature recorder will be removed by the Principal Investigator and will be sent to Ames Research Center for readout and ultimate turnover to the Principal Investigator.

7.2 ENVIRONMENTAL HISTORY AND OTHER ORBITER SUPPORT DATA REQUIRED

7.2.1 SIR-A

Support data required by the SIR-A experiment are described in subsection 4.1.2.2.

7.2.2 SMIRR

The following environmental data from the mission are required: cold plate temperature, launch and landing vibration levels (mechanically and acoustically induced), and the time of effluent discharges when the cargo bay doors are open.

7.2.3 FILE

Support data consists of ephemeris data and Greenwich Mean Times for the flight. The environmental parameter that could have the most influence on the FILE data is temperature. The color film may experience higher temperatures during prelaunch, reentry, and postlanding than are ideal, causing some color degradation. Time histories of the temperature and

humidity of the cargo bay would be requested from JSC if this is found to be necessary for data analysis.

7.2.4 MAPS

The environmental parameter that will have the greatest influence on the quality of the data is the temperature. The film is most affected, high temperatures causing rapid color degradation. Time histories of the cargo bay will be requested from JSC if this is found to be necessary. Consideration is being given to the application of peak temperature indicating strips to the inside of the film cassette.

7.2.5 OCE

The OCE scanner's preferred operation temperature is in the range of 15^{o}-30^{o}C for normal operation. The instrument may become out of calibration if the environmental temperature exceeds the temperature limits of -20^{o}C to 50^{o}C. Time histories of the pallet temperature which exceed the above limits should be made available to the OCE team.

Also the time of the Orbiter's effluent discharges (for the reasons given in 5.3.5), the Orbiter's launch and landing vibration levels, and other environmental data are required for post-flight instrumental checkup.

Ephemeris data which contains the Orbiter's altitude, attitude (corrected for IMU) and velocity are required. There is also required location information defined in terms of the Earth latitude and longitude coordinates along a best estimated track. This Orbiter support data will be incorporated in the CCT as part of the flight documentation record.

7.2.6 NOSL

The most critical environmental parameter is temperature. Film should not be allowed to remain at temperatures of over 100^{o}F for periods of more than 15 minutes.

7.2.7 HBT

The temperature in the middeck locker for the mission as well as the cabin air pressure are required.

SECTION 8. DATA PROCESSING

SECTION 8. DATA PROCESSING

Data processing, as used here, refers to the processing of the flight data in the formats and media used during collection, recovery and initial storage, to produce intermediate data products which can be used for analysis. This includes film developing, digital data decalibration, correlation with ephemeris data or ancillary data necessary to analysis, etc. These processes are described for each experiment; also, the processing flows are presented in Hierarchy Input, Process and Output (HIPO) format.

Figures 8.0-1 through 8.0-13 present data flow diagrams and schedules for the experiments. These figures give an overview of data processing and analysis activities. The analysis activities are addressed more fully in Section 10, Data Analysis Requirements.

8.1 SIR-A

8.1.1 INTRODUCTION

The procedure for the photometric handling of the SIR-A film data is similar to that of SEASAT-A SAR. In the development of the original signal film the following parameters will be used by the Radar Photo-Lab as fixed standards.

a. Gamma (Log-Log slope of the straight line)
b. D-max. (maximum density of the straight line)
c. D-min. (minimum density of the straight line)
d. Base-fog (Density resulting from inherent base characteristics and development without exposure)
e. Mid-range density point (found in the middle of the straight line)
f. Temperature
g. Film processing speed
h. $\pm$ tolerance levels for items 1-7

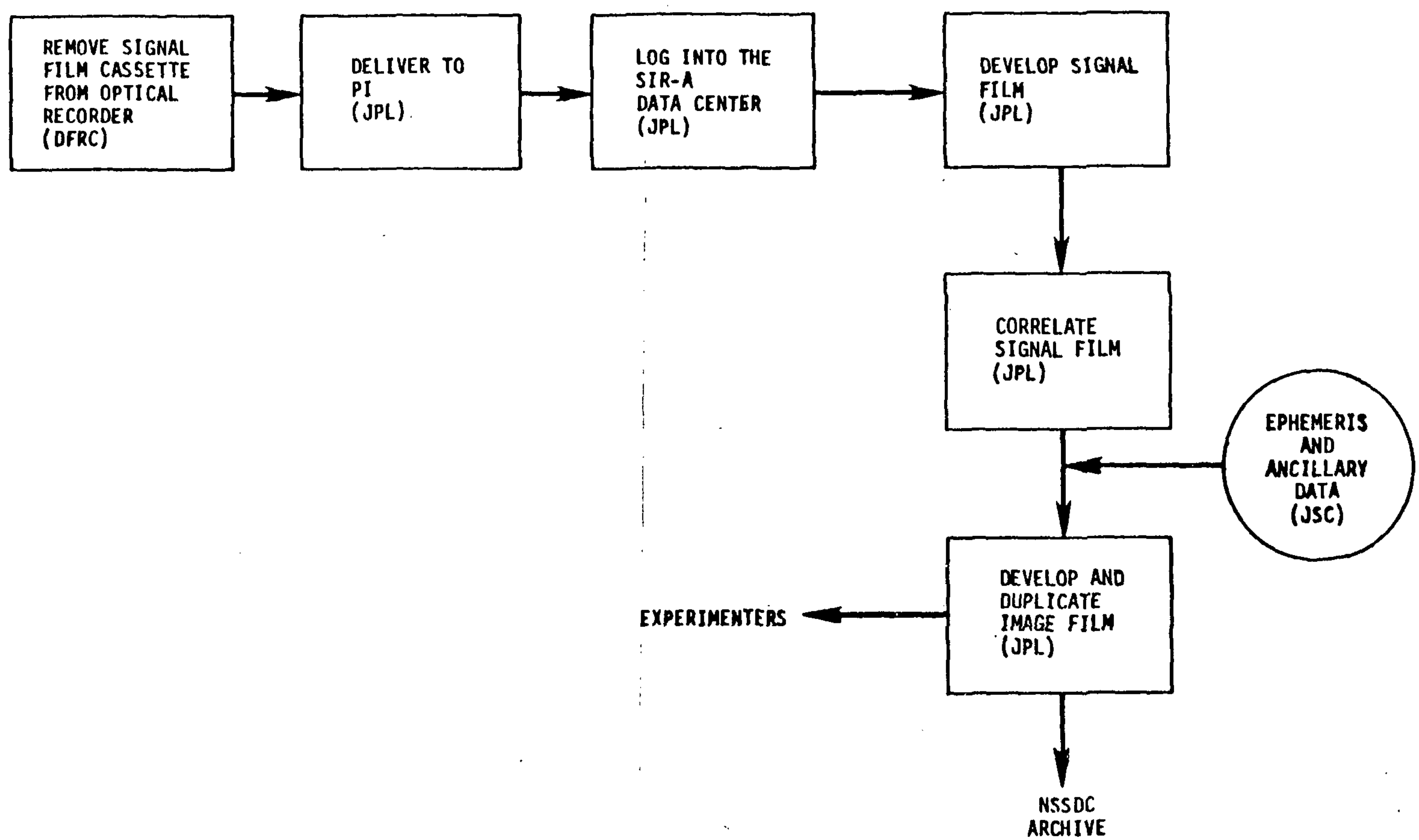


Figure 8.0-1. SIR-A Data Flow Diagram

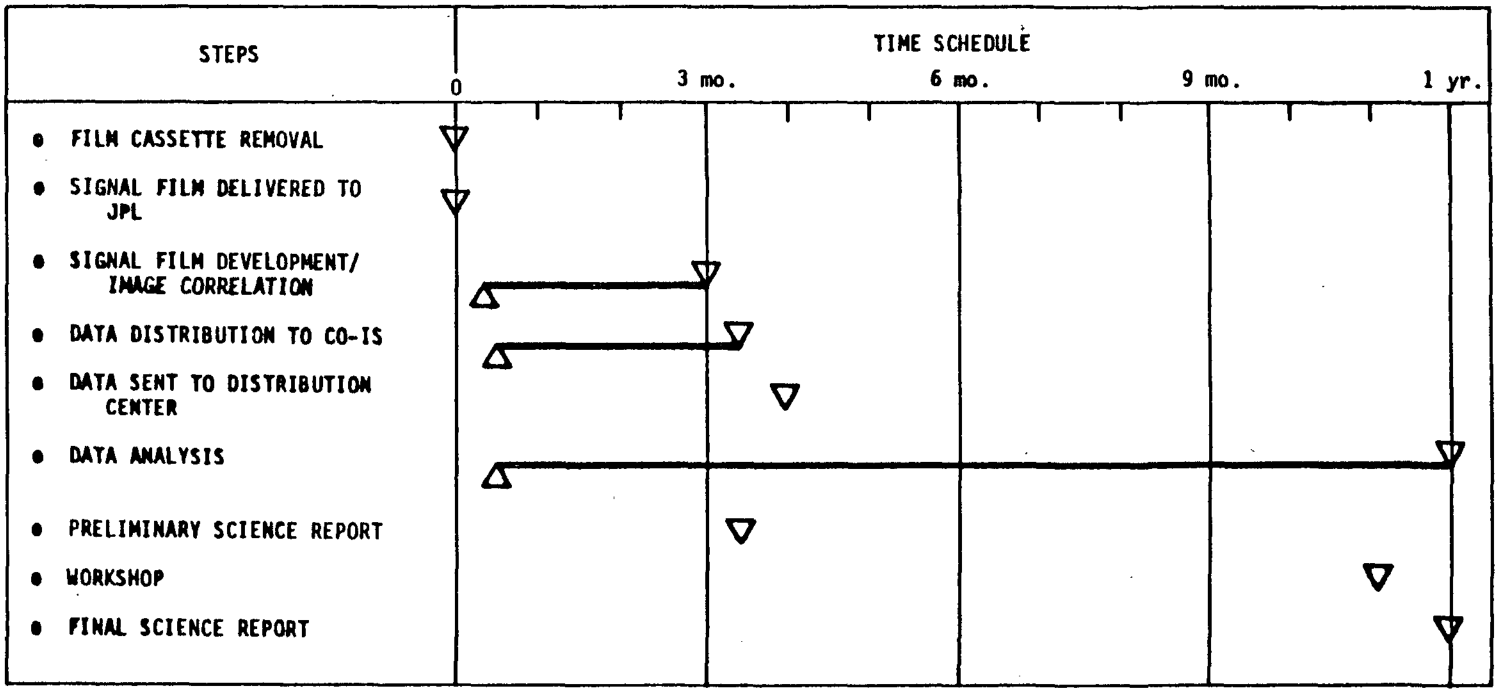


Figure 8.0-2. SIR-A Data Analysis Schedule

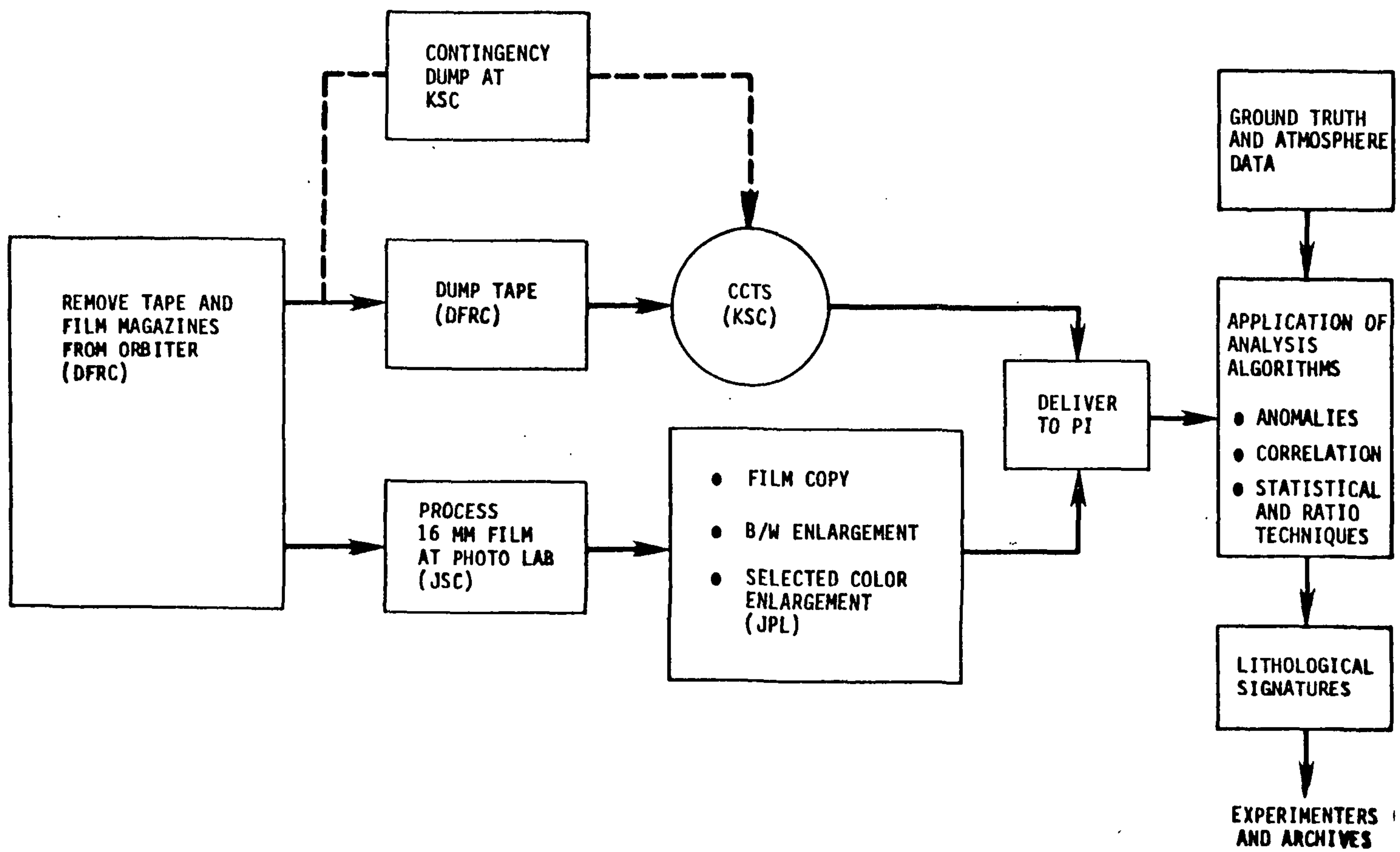


Figure 8.0-3. SMIRR Data Flow Diagram

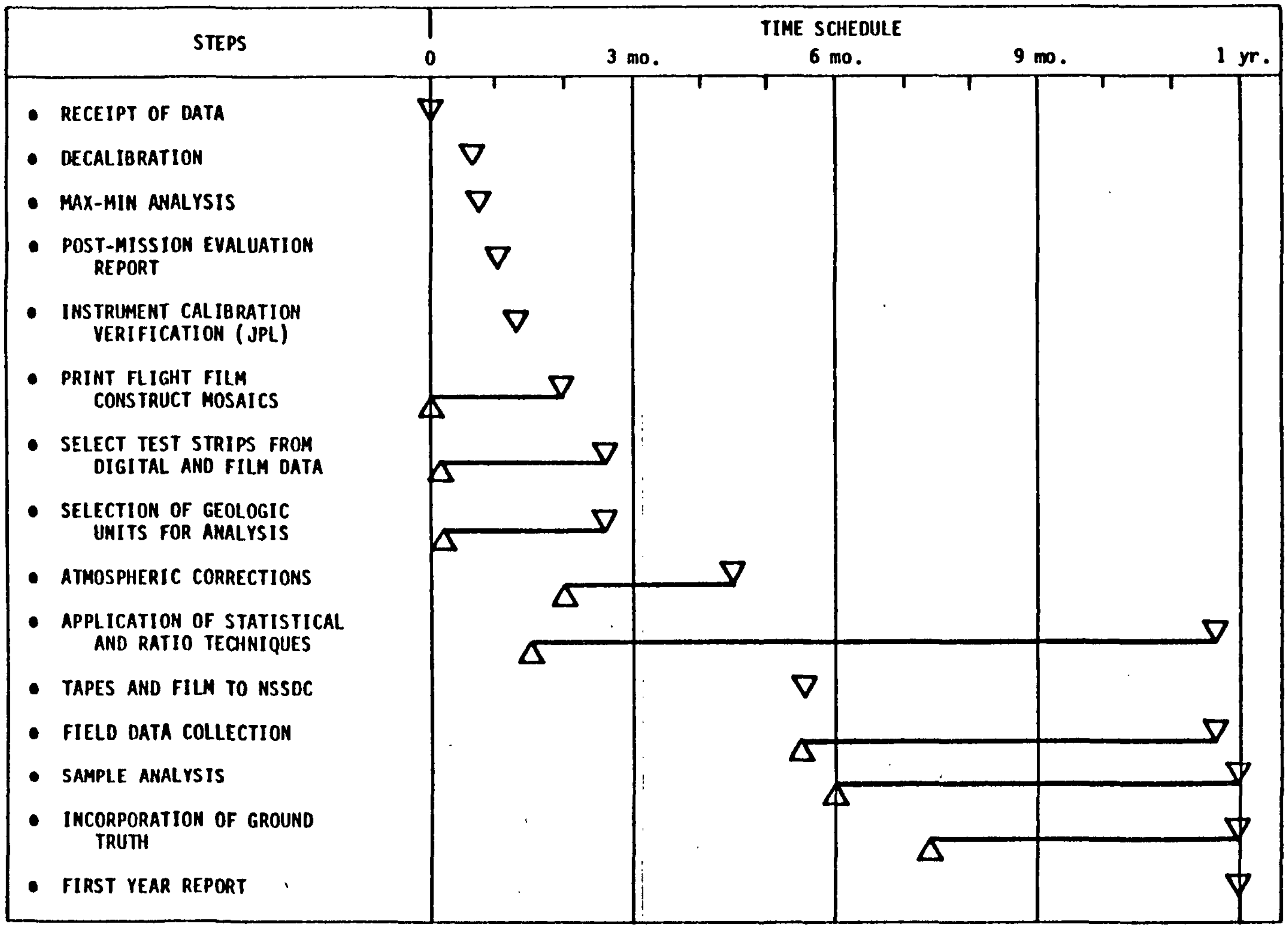


Figure 8.0-4. SMIRR Data Analysis Schedule

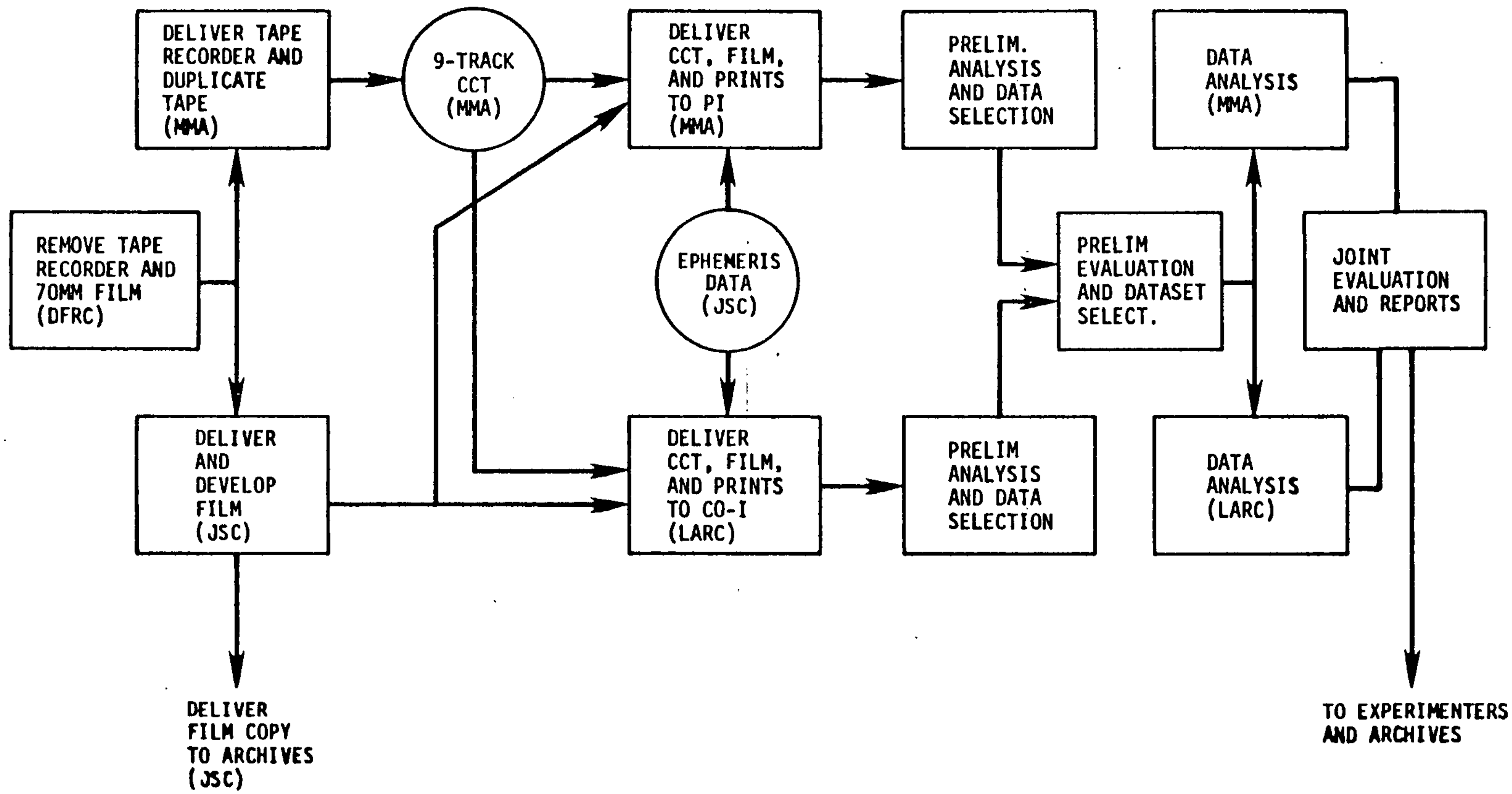


Figure 8.0-5. FILE Data Flow Diagram

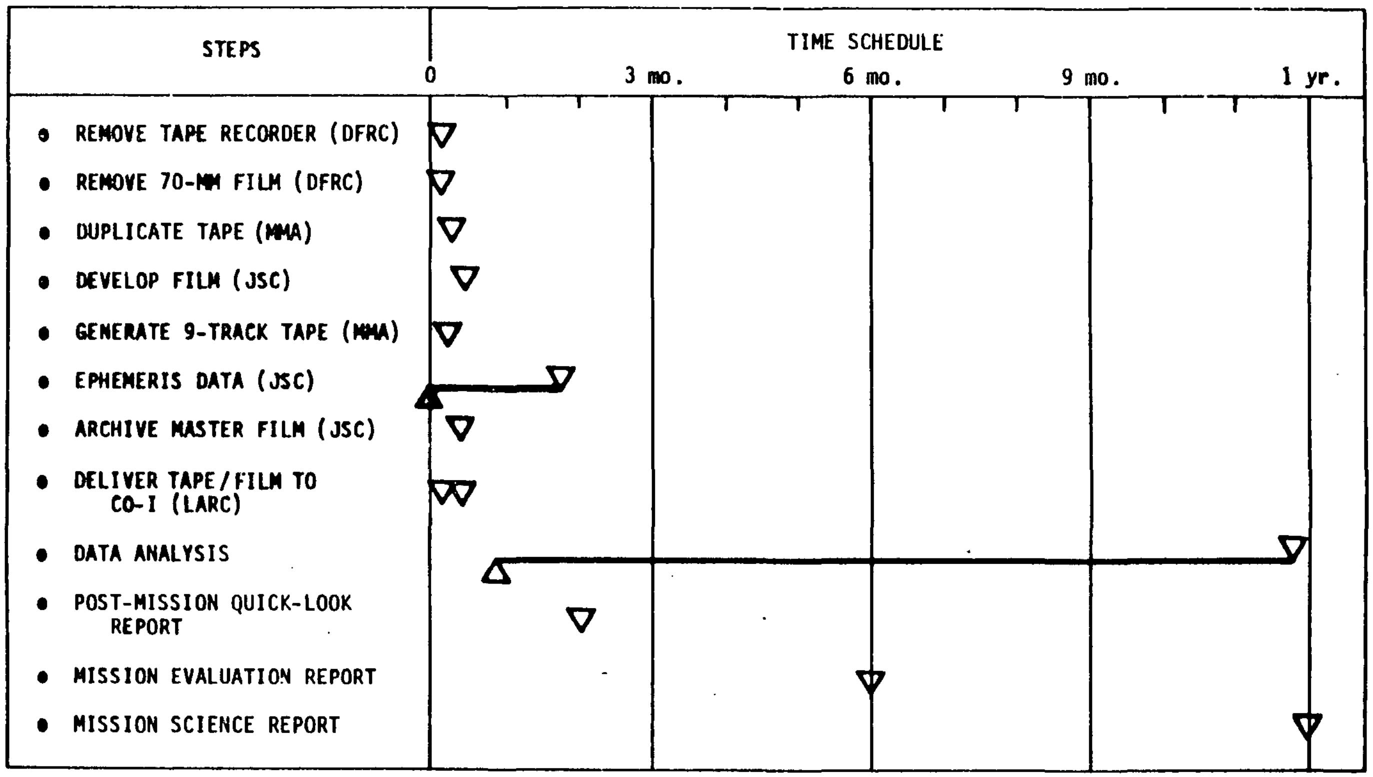


Figure 8.0-6. File Data Analysis Schedule

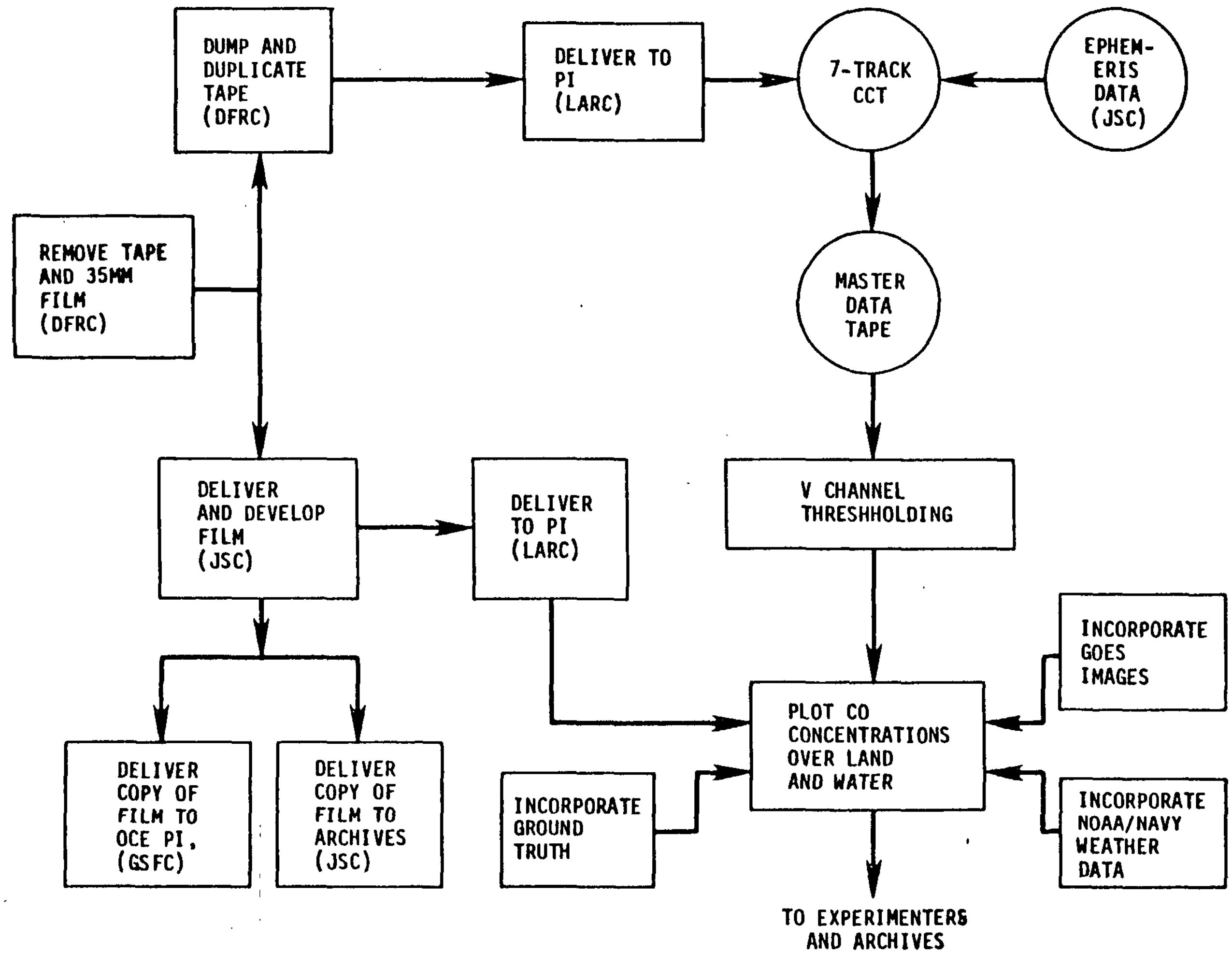


Figure 8.0-7. MAPS Data Flow Diagram

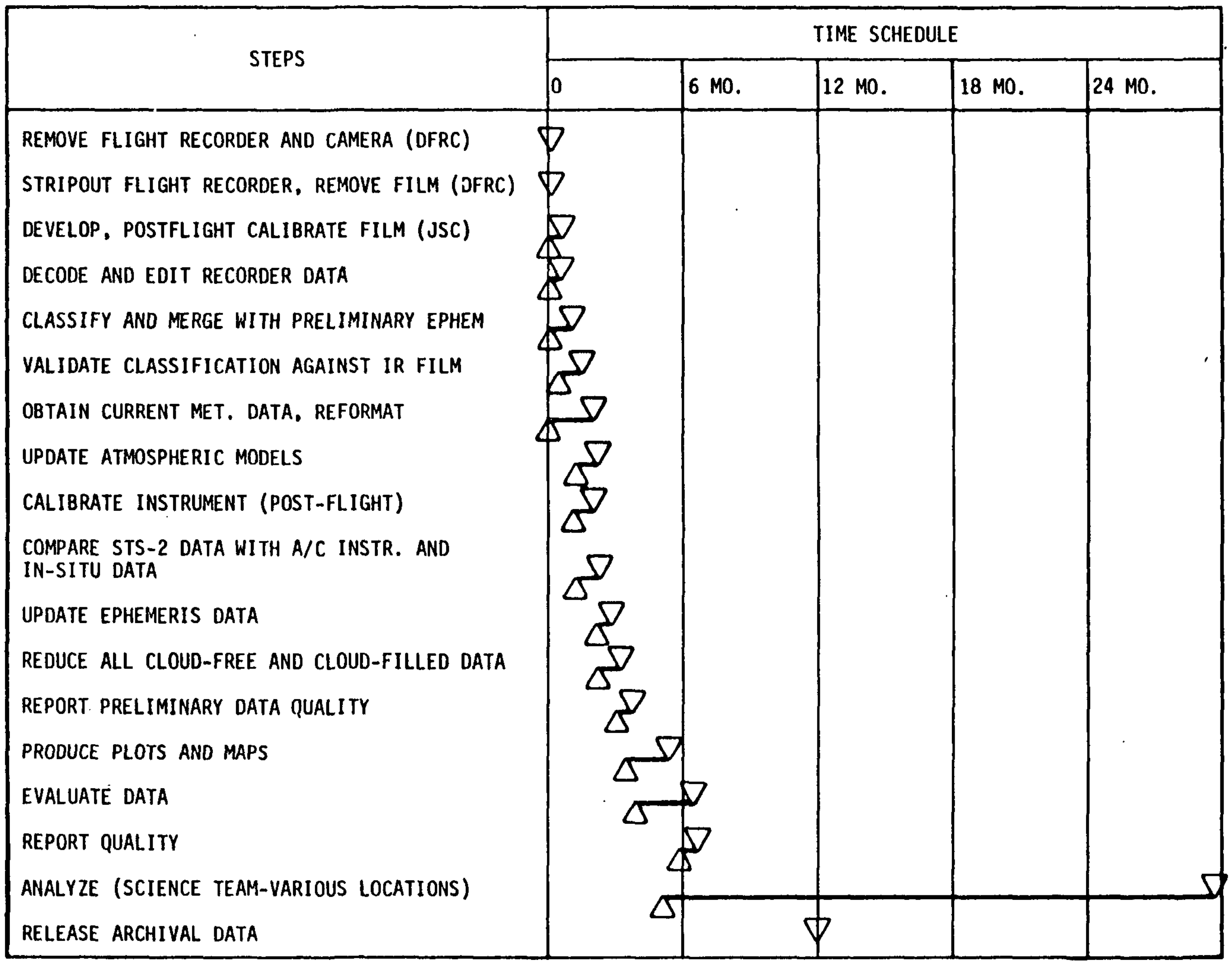


Figure 8.0-8. MAPS Data Analysis Schedule

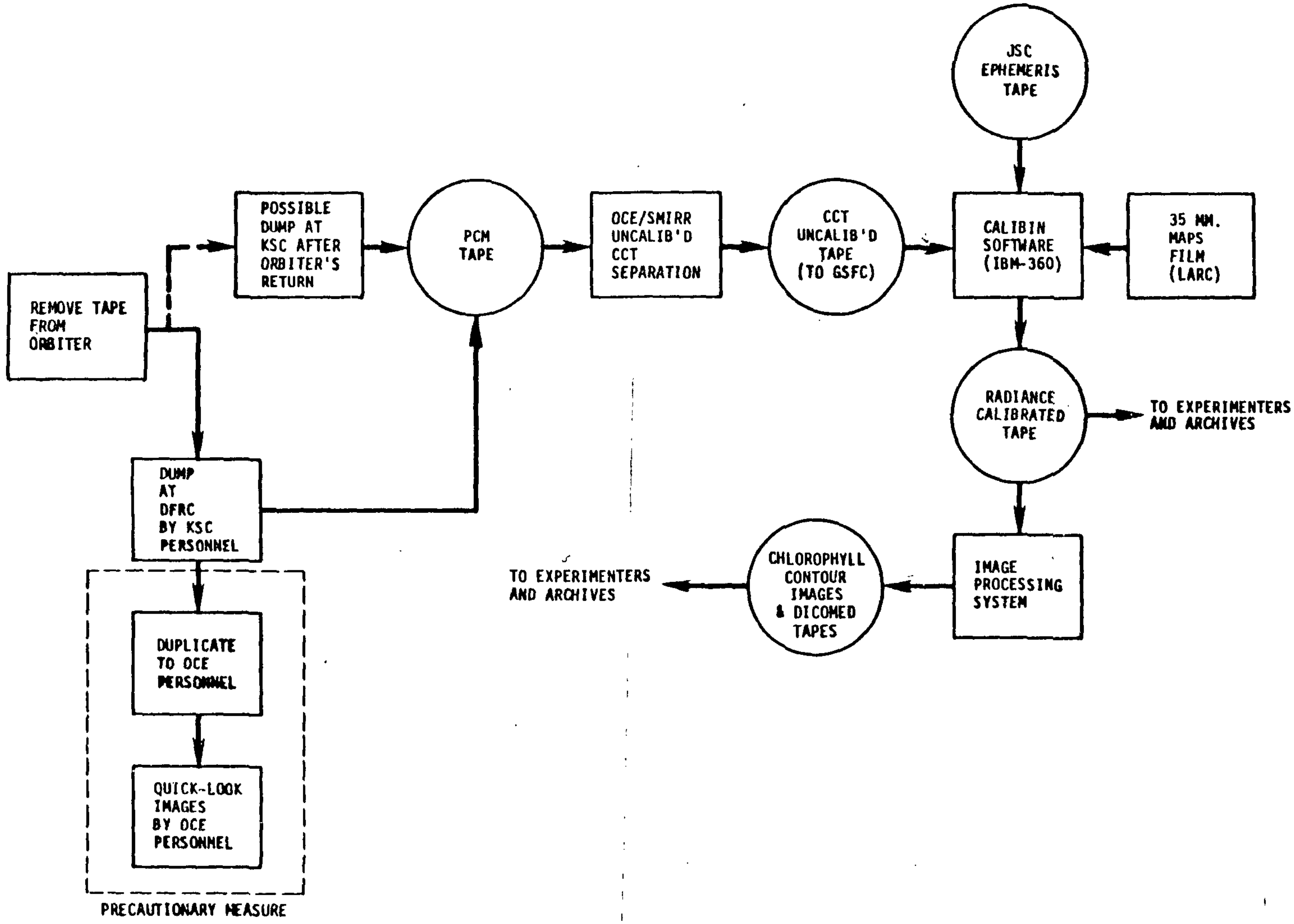


Figure 8.0-9. OCE Data Flow Diagram

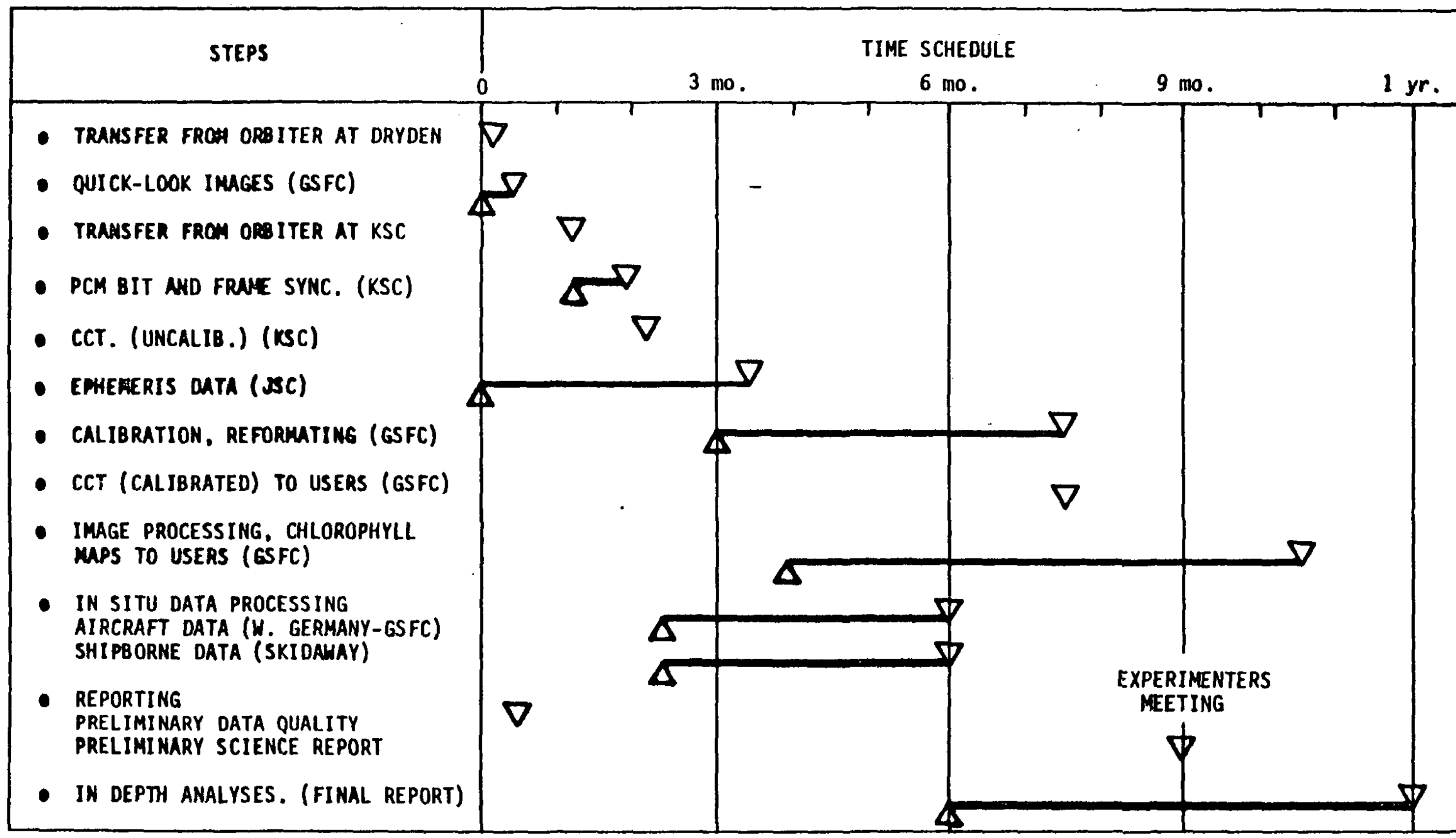


Figure 8.0-10. OCE Data Analysis Schedule

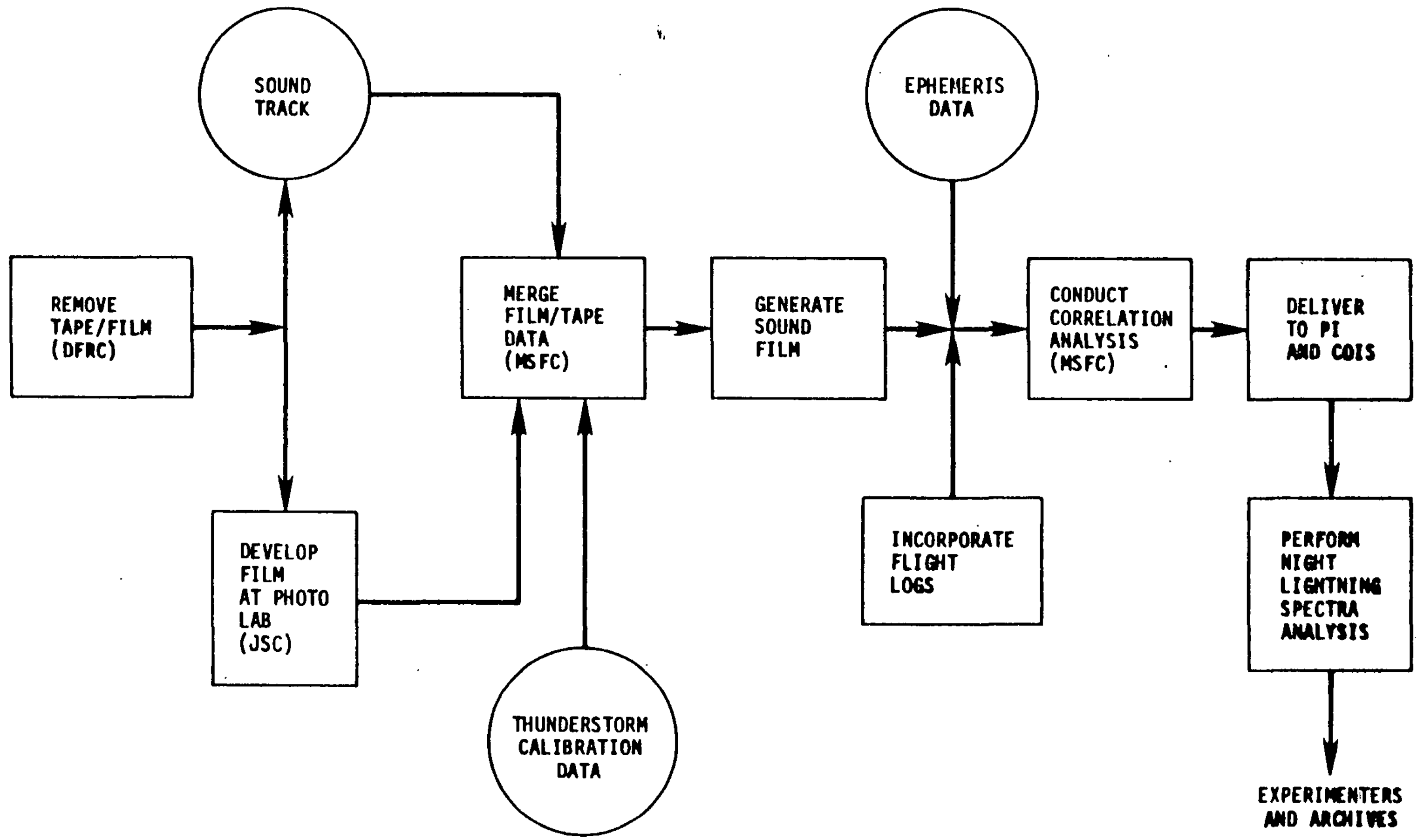


Figure 8.0-11. NOSL Data Flow Diagram

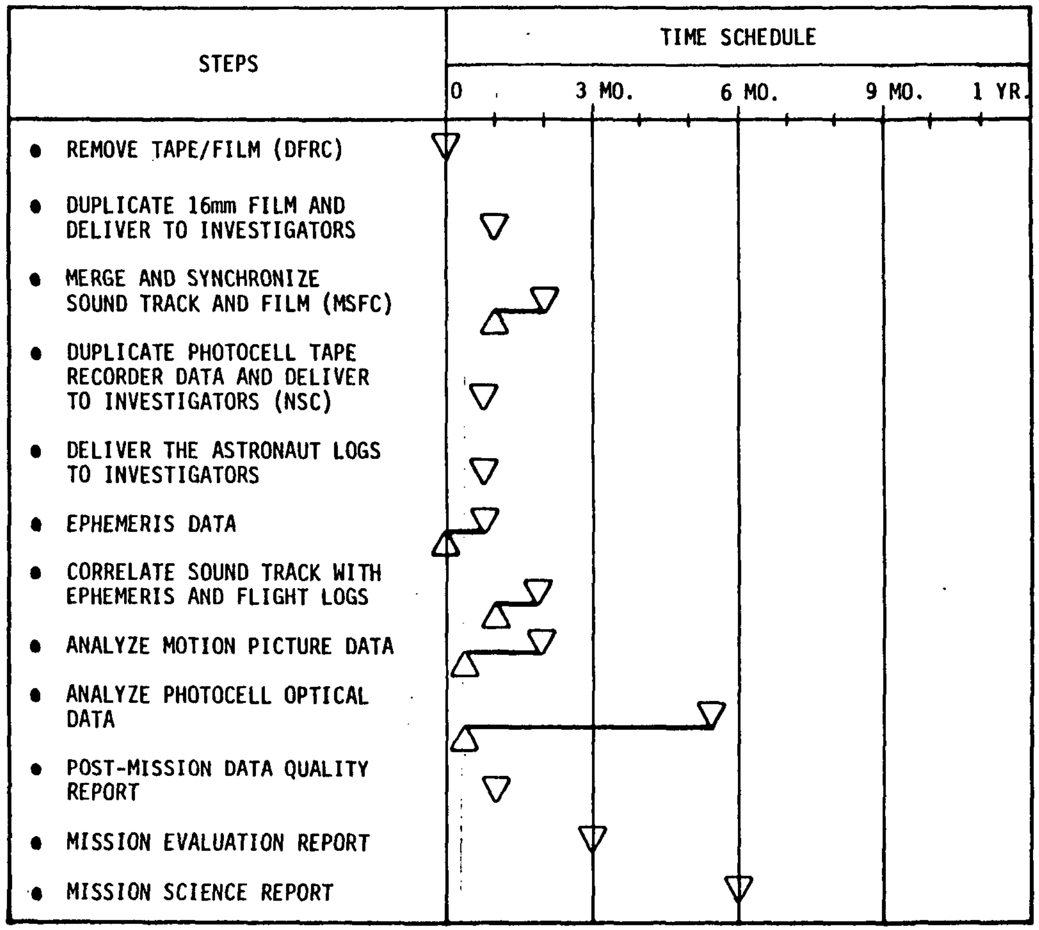


Figure 8.0-12. NOSL Data Analysis Schedule

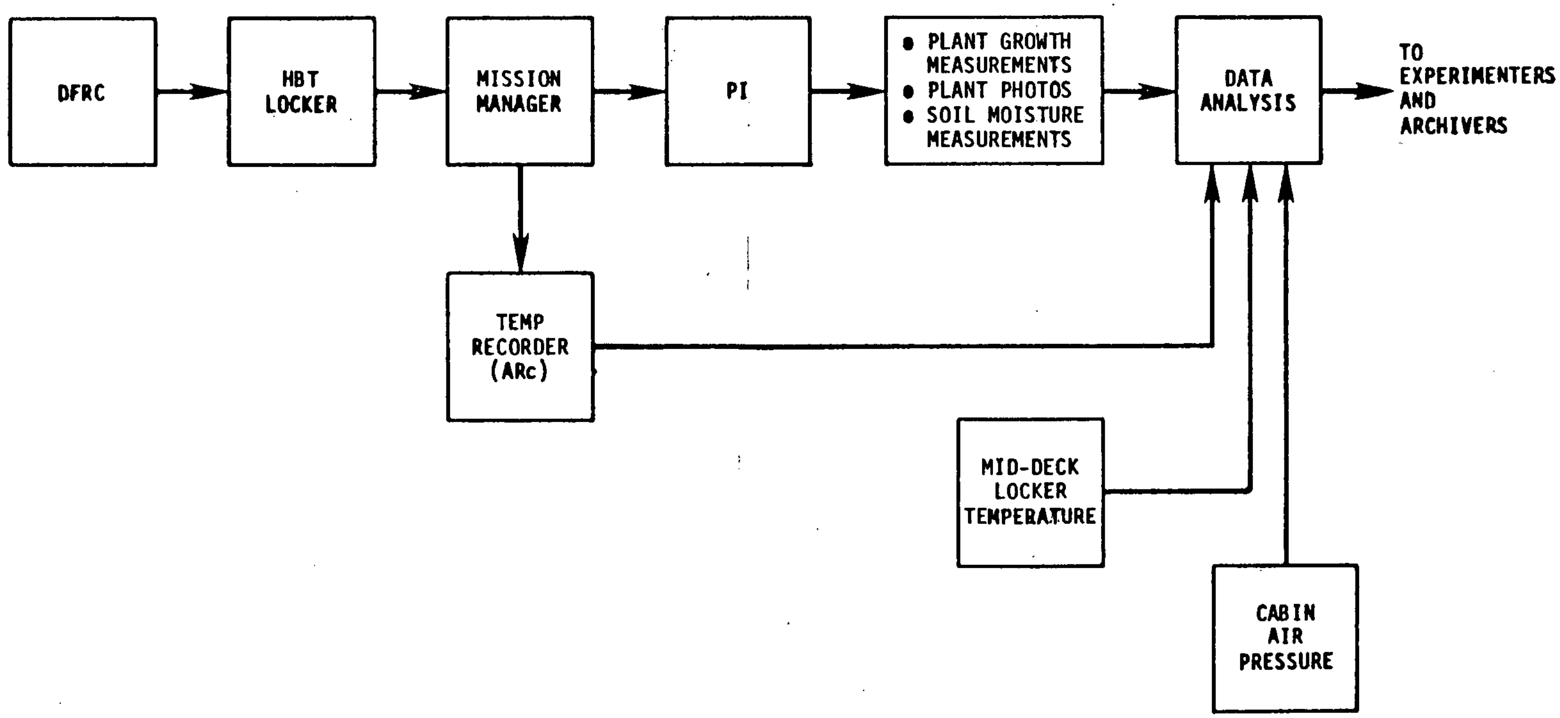


Figure 8.0-13. HBT Data Flow Diagram

The aim points for each parameter will be jointly agreed to by the SIR-A processing team and the Radar Photo Lab in advance of the actual start of the mission.

Upon receipt of the original signal film at JPL, the film will first be delivered to the SIR-A Library where it will be logged in and properly documented. The film will then be delivered to the Radar Photo Lab for preprocessing.

The data processing flow diagram for the SIR-A is given in Figure 8.1-1.

8.1.2 PREPROCESSING

8.1.2.1 Mechanical Stability of the Versamat Signal Film Processor. Due to the length and fragility of the signal film, plus the fact that the signal film is a one-time effort only, it is paramount that the film processor be in a prime mechanical operating condition. To assure this, the Versamat will be fully rebuilt. This shall be completed one month prior to actual SIR-A film processing to allow adequate testing of the machine's mechanical stability.

8.1.2.2 Certification of the Sensitometer and Densitometer. All sensitometric equipment (sensitometer and densitometer) will be certified on a daily basis prior to production of SIR-A data imagery.

8.1.2.3 Certification of Processor Chemistry Certification. The Kodak Versamat Film Processor Model 11-CM will be certified as to chemical activity prior to actual processing of SIR-A data. This will include the statistical plotting of processor trends in order to detect in advance any "out of control" situation that may be impending. Following certification of the Versamat, the signal film will be processed. After processing, the film will be visually inspected for defects, then read for photometric documentation. The signal film will then be delivered to the SIR-A correlator operator, along with exposure recommendations for correlation.

INPUT

Premission Data
- o Aircraft
- o Ground truth
- o Spacecraft

Flight Data
- o Films
- o Environmental history

Post-mission data
- o Microfiches or hard copies
- o Ground truth

PROCESSING

Preprocessing
- o Signal film development
- o Image film development
- o Duplications of signal and image film

Processing
- o Incorporation of ephemeris and ancillary data
- o Correlation of image film

OUTPUT

- o Signal film, original negative 70mm x'approximately 3500 ft
- o Signal film, master positive, (10 copies)

Two-Dimensional images of the Earth's Surface:
- o Image film, original negative, 5 in.
- o Image film, master positive, 5 in. (2 copies)
- o Image film, duplicate negative, 5 in. (12 copies)
- o Strip contact print, 5 in. (copies as needed)

Figure 8.1-1. Data Processing Flow for SIR-A

8.1.3 PROCESSING

8.1.3.1 Crossovers and Replenishment. Since established reference points (gathered over the last 1 1/2 years) exist for the proper replenishment rates based on 2421 sensitometric wedges, these wedges will be used as a guideline for replenishment. The procedure will be as follows:

a. Perform a crossover between the 3493 and 2421 control wedges (to possibly be used later as an additional data point).

b. During actual processing, control wedges will be run down the side of the processor every 15 minutes and will be numbered, read, and charted. After the charts demonstrate continuity (at least three strips in succession which do not reveal an out-of-control trend), the strips will be run every 30 minutes.

8.1.3.2 Breakdowns. If the Versamat should break down, or if the film becomes hung up in any fashion, then the drive will immediately be shut down. Since the entire processing area will be under safelights, the covers will be removed from the processor and the problem will be assessed. If it is apparent that a proper fix can be obtained in less than a minute or so, then the fix will be implemented. However, should the problem be deemed more severe, then the film shall be cut and placed in a safe area. The fix shall then be made and the processor retested both mechanically and sensitometrically.

8.1.3.3 Film Take-up. Since the film will be cut into shorter lengths (less than 600 ft.) as it exits the processor, normal Seasat film take-up procedures will be followed. Enough 600-foot reels, already assembled, will be present to take-up the entire signal film length. Spare reels will also be immediately available. A spare take-up motor will also be immediately available.

Three people will be present at all times. One person will observe the film feed. One person will observe the take-up. The last person will act as a spare/relief. Because the signal film is processed at such a low speed (5 ft/min) exchanging reels of take-up motors is extremely easy.

8.1.3.4 Correlation Procedures. After production of the required number of signal film duplicates, the rolls should be checked for any physical defects such as scratches, bad focus, or lost data. Following that, the 21-step grey scale should be read and the gamma plotted. If the films meet system's tolerances, they then may be delivered to the SIR-A Data Library.

At this point, the duplicate signal films will be correlated through the optical correlator. Actual correlation procedures will be conducted by Tom Bicknell, Tom Andersen, and the SIR-A team. Scheduling will be done by the SIR-A Data Library and the SIR-A team. After correlation, the undeveloped image film (Kodak Linagraph Shellburst Film, 2476) will be delivered directly to the Radar Photo Lab for processing.

8.2 SMIRR

8.2.1 DATA PREPROCESSING

a. Data Integrity Verification. When the CCTs are delivered to JPL, they will be read to verify that all of the data are present and that they are error-free. It is expected that the source of errors can be determined by inspecting the data so the payload recorder can be released or played back again.

b. Decalibration. The data on the CCTs will be convolved with the appropriate set of radiometric calibration data on IBM 360/158 to create data tapes that list the radiance of each scene observed by the instrument. These data will be used for the scientific analysis.

8.2.2 DATA PROCESSING

Data processing will consist of manipulation of the digital SMIRR data including decalibration, the correlation with the ground position obtained from the 16 mm camera and the ephemeris data and incorporation of the post-mission ground truth data. Data processing for analysis includes: (1) application of the light transfer curves (see Figure 3.2-5) obtained from the final post-mission calibration with modification through the use of on-board inflight calibration data to obtain decalibrated data, (2) determination of the range of 10 channel spectral signatures obtained

worldwide; (3) determination of the atmospheric transmission by use of the Lowtran-5 model*; (4) incorporation of radiosonde data into the Lowtran model where available; (5) resampling of the data to superimpose all filter measurements on each individual sequential IFOV; (6) extraction of data from regions having known geologic units; (7) application of analysis algorithms such as ratios, principal components and canonical statistical analysis (Science, Vol. 211, pp. 781-791); (8) incorporation of post-mission data in particular ground truth data for analyses purposes. The above eight processing steps will be done on an IBM 360/158. This data processing flow is shown in Figure 8.2-1.

Black and white and color 16-mm film will be processed by the JSC photolab in accordance with the SMIRR film processing memorandum signed by Noel Lamar in June 1981. There are no specific sensiometric requirements for film processing since radiometric measurements are not being made with the cameras. However, test strips made with the SMIRR cameras prior to launch will be developed prior to flight film processing to ensure proper processor adjustment. Duplicates will be printed as discussed in Section 9.2.2.

8.3 FILE

The FILE data processing plan is outlined in Figure 8.0-5 and Figure 8.3-1. Figure 8.0-5 shows that the data analysis and reporting activities will be a joint effort between the Langley Research Center and Martin Marietta Aerospace, consonant with the dual experiment Investigator roles for these two organizations. The JSC Photographic Technology Division will process

*The Lowtran program calculates atmospheric transmission and scattering based on internally contained models or externally input parameters such as temperature pressure, dew point and others derived from any source. Specifically, radiosonde data and NOAA sounder data can be used to derive the local model.

INPUT

1. Premission data
   - o Rock tests
   - o Aircraft flight tests
2. Flight data
   - o Films
   - o PCM data
   - o Environmental history
   - o On-board calibration
3. Post mission data
   - o Calibration
   - o Ground truth

→

PROCESSING

1. Preprocessing
   - o Data integrity verification
   - o Decalibration
2. Processing
   - o Application of light transfer curves
   - o Range of spectral signature determination
   - o Atmospheric transmission using LOWTRAN-5 model
   - o Incorporation of radiosonde data
   - o Resampling
   - o Extraction of data sets over know geologic units

→

OUTPUT

Selected regional data with known geologic units
- o CCT's
- o (6-mm film) (B&W, color)
- o Prints

Figure 8.2-1. Data Processing Flow for SMIRR

INPUT

1. Premission data
   - o Mission profile
2. Flight data
   - o Films (70mm color)
   - o Tapes
     - a. 0.65 m radiance image
     - b. 0.85 m radiance image
     - c. GMT of each scene
     - d. Classification summary
     - e. Cloud reference
3. Post-mission data
   - o Ephemeris data

→

PROCESSING

- o Photo processing
- o Tape dump and format
- o Calibration
- o Data set selection
- o Incorporation of ephemeris

→

OUTPUT

- o Positive duplicates of 70mm flight film (4 copies)
- o Color prints, 8x10 in., of each frame (6 copies)
- o 9-track CCT (4 copies)

Figure 8.3-1. Data Processing Flow for FILE

the one magazine (about 120 frames) of Kodak QX-824 color film, and will also provide these data products:

a. Two positive transparencies copied from the processed flight film and three 8 x 10 inch color prints of each frame of imagery, supplied directly to Martin Marietta Aerospace, Denver (within two weeks after STS-2 landing).

b. Two positive transparencies copied from the processed flight film and three 8 x 10 inch color prints of each frame, supplied directly to NASA/LaRC (within 2 weeks after STS-2 landing).

c. Internegatives

The JSC Photographic Technology Division also will load the FILE film camera and provide pre-flight sensitometry calibration of the flight film and on a control sample of the film. Before processing the film, JSC will perform complementary post-flight sensitometry calibration on the flight and control films. By means of these calibrations, it should be possible to isolate film degradations due to the pre-launch, flight, and/or re-entry environments. The original flight film will be temporarily stored in a controlled environment at JSC.

The FILE Lockheed flight tape recorder will be taken to Martin Marietta in Denver and dumped onto 9-track computer compatible tapes (CCTs) within one week after landing at DFRC. (Note: The FILE recorder uses a non-standard data recording format, as well as a non-standard electrical and software interface). The tape dump will provide CCT's for both LaRC and Martin Marietta (experiment investigators) for use in processing and data analysis at Martin and at Langley. The subsequent data analysis is described in Section 10.3.

Parallel with the FILE data analysis progress, the FILE experiment will be shipped from KSC back to Martin Marietta for check-out and re-calibration. The pre-flight calibration (see Section 3.3.3) measurements will be repeated after the flight, if the experiment is still operational, to determine what degradations may have occurred. If degradations in the performance are detected from the pre-flight and post-flight calibrations,

efforts will be directed toward isolating the causes, and the specific relationship to the STS-2 mission. Possible correlations between degraded experiment functioning and degradations in data obtained, if any are observed, will be examined. If the experiment is not operational at the end of the mission, efforts will be directed toward determining the cause of the failure, the time of failure, and any data (mission) relationships.

Within about 10 weeks after the STS-2 mission, the Shuttle ephemeris data will be made available by JSC to LaRC and Martin Marietta. These data will provide a basis for locating important ground truth data for use with the 70-mm FILE photographs, and the basis for a new FILE master tape with latitude/longitude data for each image. The need or lack of need for supplementary photographic data will have been determined by that time, through evaluation of FILE color photographs and MAPS color-IR photographs (to be examined for useful correlation with FILE photographs).

8.4 MAPS

8.4.1 INTRODUCTION

The primary MAPS data set is the series of radiometric measurements made and recorded by the OSTA-1 instrument.

False color infrared imagery obtained from a camera mounted on the instrument base-plate will provide information on the degree of cloud cover in the instrument field-of-view during daylight operation.

Meteorological information will be used to construct atmospheric models in the form of pressure, temperature and humidity profiles which are to be used in the data reduction process. Standard 12-hour analyses, individual rawinsonde sounding, and aircraft data may be used. One of the objectives of the experiment is to assess the required precision of meteorological data used in the reduction.

A prototype of the OSTA-1 instrument will be flown aboard a Learjet to provide correlative data. Air samples will also be collected during these underflights and later analyzed by gas chromatography to provide independent assessment of CO concentrations.

Preliminary ground track estimates will be used to match the flight path of the aircraft as closely as possible to the orbital track of STS-2.

Final ephemeris data will be used to determine the exact aim point and field-of-view of measurements made from STS-2.

8.4.2 PREPROCESSING

Following strip-out of the data from the flight tape recorder and delivery of the resulting magnetic tapes to LaRC, the data will be written onto a tape in a format convenient for processing at the LaRC computer complex.

During this phase, preflight calibration factors will be used to convert from raw counts to units of temperature, voltage and radiance. Also during this phase, the values of various parameters will be examined to determine that the instrument has operated within tolerances. Out-of-tolerance conditions will be flagged and summarized. A strip-chart record will be produced of the V, ΔV, $\Delta V'$ signals, temperatures of the reference black body and the base plate, the automatic electronic balance parameter and the camera operation pulse. This record will be used as a convenient visual reference to instrument operation history. If out-of-tolerance conditions can be related to unanticipated variations in the baseplate temperature, an effort will be made to correct these conditions by using in-flight calibration data. A consistent pattern of such conditions, however, may indicate the need to suspend processing until an extensive post-flight checkout and recalibration of the instrument has been completed.

The next step in preprocessing will be to subdivide the data into day and night categories based on the camera mode, and cloud-free, cloud-filled, and partially cloudy field-of-view using the V channel signal. A lower limit will be established for the V signal below which the field-of-view is assumed to be more than 90 percent filled by high clouds. High-frequency variation of the V signal will be used as an indicator of a partially cloudly field-of-view. For daytime measurements, this sorting process will be verified using IR imagery. Time, latitude and longitude will be collated with the observed data and written on a magnetic tape.

8.4.3 PROCESSING

Initial processing will concentrate on data with cloud-free and cloud-filled fields-of-view. A set of 3 to 6 climatological models will be used to construct atmospheric models corresponding to the estimated track of STS-2 prior to launch. The corresponding coefficients will be computed and used to obtain "quick-look" inferrals of CO. Meteorological observations concurrent with the STS-2 mission will be used to update atmospheric models on a limited basis to intercompare results of STS-2, the MAPS aircraft instrument, and gas chromatograph analyses of "grab-samples". Agreement among these three observations to within 30 percent will be considered reasonable. It is estimated that this phase of the processing will be complete within 60 days after the completion of the mission.

After receipt of final ephemeris data from JSC and comparison with initial estimates, with updating where necessary, the processing of the remainder of the cloud-free and cloud-filled data will be completed within 4 to 6 months after STS-2 landing. The data products will include CO vs. time, CO vs. latitude and longitude, hemispheric averages, and such other products as the Science Team may deem useful.

A data processing flow chart is shown in summary in Figure 8.4-1.

8.5 OCE

8.5.1 PREPROCESSING

The OCE data is preprocessed on-board the Orbiter using a digitizer which converts the analog signal into 10-bit binary words in PCM format. These digitized data along with the corresponding analog data and other associated parameters are recorded on 10 tracks of the Orbiter payload tape recorder.

8.5.2 PROCESSING

The conversion of OCE data recorded on-board the Space Shuttle into a form which is conveniently usable by the analyst requires several data

INPUT	PROCESSING	OUTPUT
1. Premission data o Aircraft 2. Flight data o Tapes (Lockheed Mark V) o Films (Kodak 35mm color) 3. Post-mission data o Near simultaneous ground truth a. CO, Air temperature, water vapor (by aircraft) b. GOES cloud cover o Local subsatellite service position o Spacecraft attitude o NOAA/Navy weather data o Ephemeris data o Calibration	o Film development o 7-track CCT generation o Radiance unit conversion using preflight and inflight calibration o Post flight calibration data comparison o Reformat CCT with ephemeris data o Master tape generation o Data separation and collection using V-channel thresholding o Data checks against film and GOES imagery o CO concentration categorization o Ground truth comparison	o CO vs. time o CO vs. Latitude/Longitude o Hemispheric coverages

Figure 8.4-1. Data Processing flow for MAPS

processing steps. The following is a brief overview of the process. The data processing flow for OCE is shown in Figure 8.5-1.

When the data tape is returned to Earth, the recorded OCE data are processed by PCM bit and frame synchronizers which interpret the value of the serial words and reorganize them into synchronized frames in a parallel format. The data are then written into a magnetic tape in a format which is readable by digital computers. These tapes are referred to as computer compatible tapes (CCT's).

The CCT's are then processed on an IBM OS/360 computer. The software is designed to produce calibrated OCE data in a format which can be readily used by analysis programs. The tapes produced by the software are referred to as calibrated tapes. These calibrated tapes have two features which facilitate use by the data analyst. First, they contain the table of conversion coefficients which are used to convert OCE calibrated voltage values into instrument observed upwelling radiance. Second, data from all eight OCE channels from a single OCE-scan line are contained in single logical records.

The calibrated tape will be produced on an IBM OS/360 computer. The normal characteristics of the tape will be 9-track, no label, density of 6250 bits per inch, variable record length, blocked records, multiple files, and maximum physical record length of 32596 bytes. Tapes with different characteristics may be produced upon need of the user.

The first file on the tape, which is the documentation file, will consist of two records. The first of these will contain pertinent information regarding the structure of the succeeding data files. It will also contain geographic and timing information corresponding to the data files. The second record will contain the conversion constants needed to produce observed upwelling radiance values from the data values found on the tape.

An arbitrary number of data files will follow the documentation file. The first record of each of these will contain documentation information relating to the particular segment contained in the file. The following

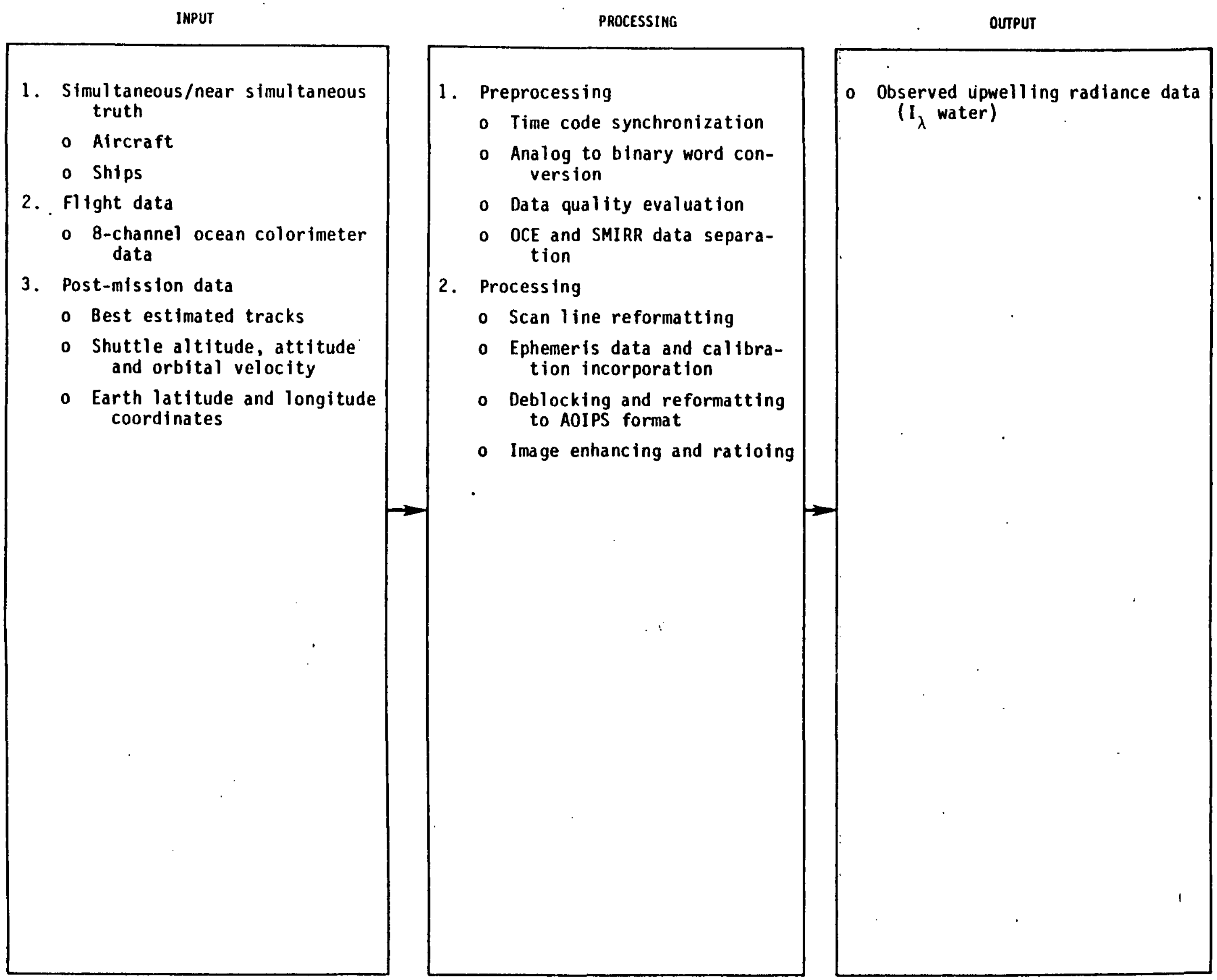


Figure 8.5-1. Data Processing Flow for OCE

records will contain the interleaved, calibrated OCE data counts with each record corresponding to one scan line.

8.6 NOSL

8.6.1 DATA PROCESSING

After the film has been developed, a copy will be made with a sound track on which will be recorded the synchronized electrical signals obtained from the photocell during the observations of thunderstorms and lightning. The synchronization of the sound track on the film will be carried out by Marshall Space Flight Center, which has already successfully synchronized signals taken with the NOSL equipment on a thunderstorm in Oklahoma.

The data processing to be carried out at the State University of New York at Albany will be concerned primarily with analysis of the photographic film. When thunderstorm clouds are visible at sufficiently close range, calculations will be made using data from the ephemerides to determine the convective energy of the cloud system and to relate this to the frequency of lightning as indicated by the photocell data. If data are obtained from a sufficiently large number of samples of land and maritime thunderstorms, it will be of great interest to see whether the relationship between convection and electrification is the same over water as it is over land.

If photographic data are obtained on the long horizontal discharges that have been reported by astronauts, the film will be carefully analyzed to determine the speeds at which the horizontal discharges propagate and to compare these with similar measurements on vertical discharges that have been made on lightning beneath clouds by Dr. Richard Orville and his associates at Albany.

When photographs of lightning discharges taken at night are of sufficient intensity to provide good spectral data through use of the diffraction grating, the resultant spectra will be analyzed by Dr. Orville using his photometric apparatus. These spectral data will then be compared with similar data Dr. Orville has been obtaining in studies made in New York, Florida, and New Mexico. NOSL data processing flow is shown in Figure 8.6-1.

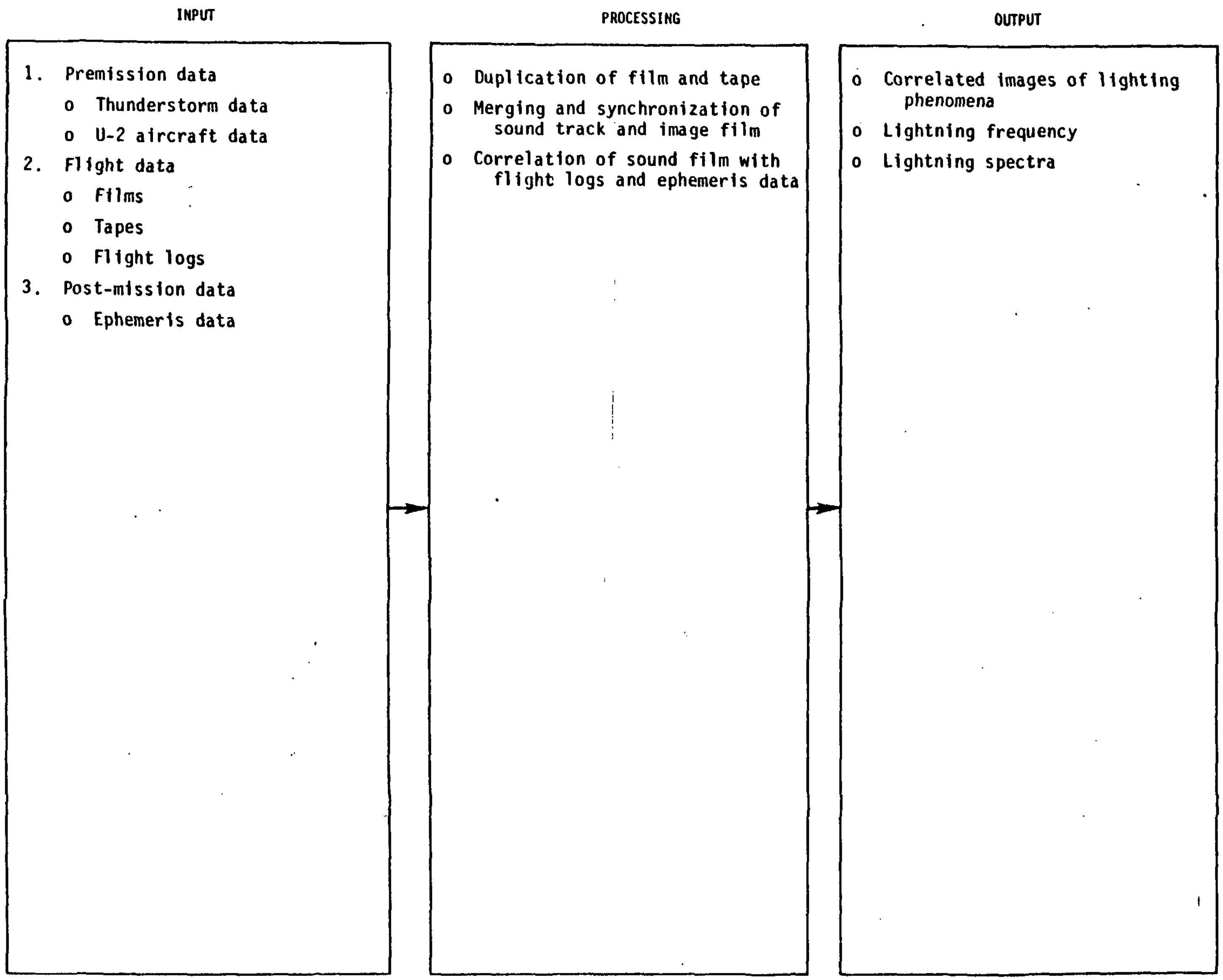


Figure 8.6-1. Data Processing Flow for NOSL

8.7 HBT

Plant photos taken by the Principal Investigator after the experiment recovery will be processed by him. HBT data processing flow is given in Figure 8.7-1.

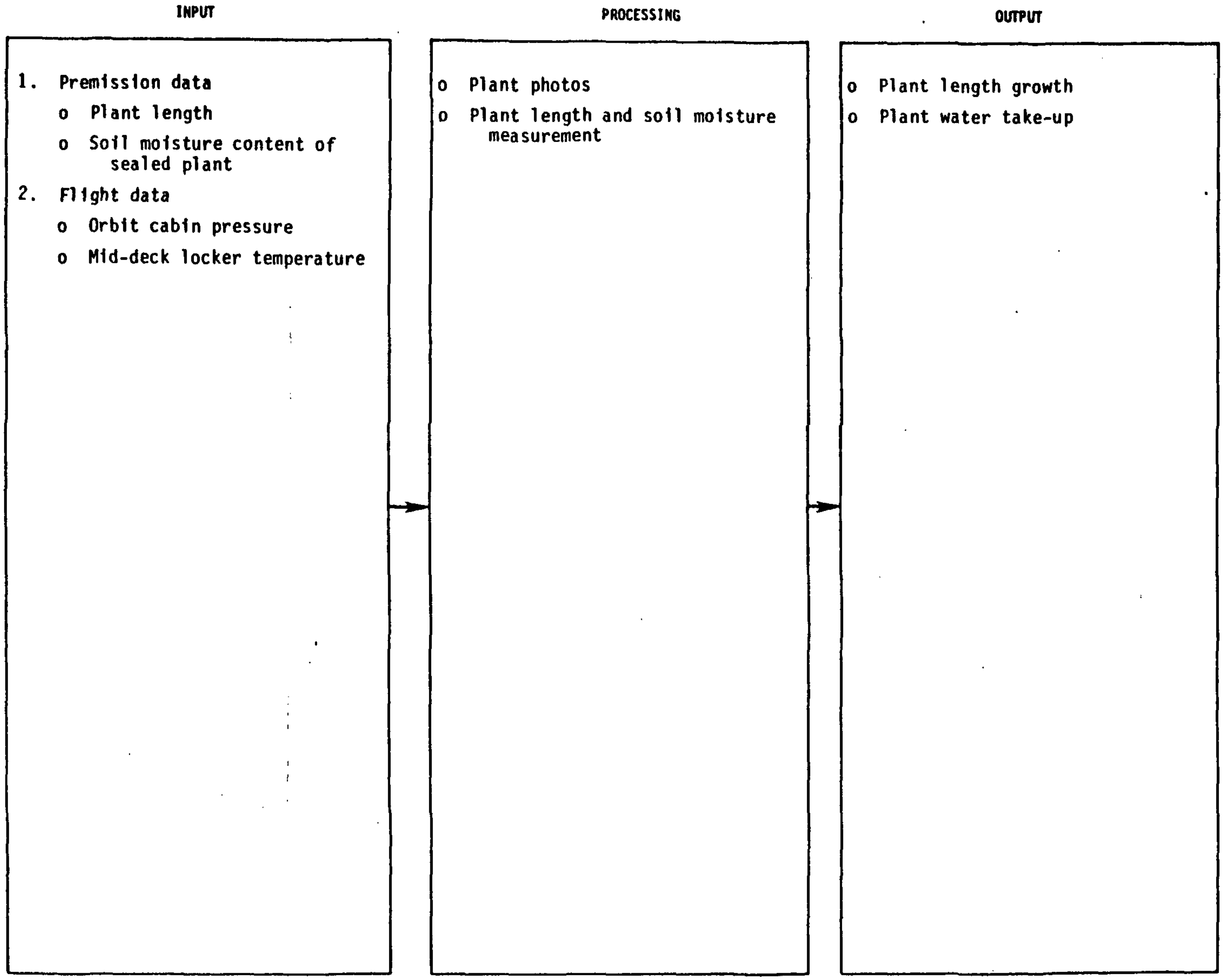


Figure 8.7-1. Data Processing Flow for HBT

SECTION 9. DATA ARCHIVING AND DISSEMINATION

SECTION 9. DATA ARCHIVING AND DISSEMINATION

After initial processing and duplication, the flight original data can be archived. The quality of data must be ascertained, and quality control on processing and reproduction must be maintained. The intermediate data products, in useable form for analysis, are then distributed to co-investigators, other investigators, and the public. The plans for these activities for each experiment are given in this section.

9.1 SIR-A

9.1.1 INTRODUCTION

This section describes the procedures from the receipt of the original image and non-image products in the JPL SIR-A Data Center through final distribution. It is expected that the correlation will start immediately when the signal film is received at JPL and will be completed in about three months. A flow diagram showing the generation of SIR-A image product is given in Figure 9.1-1. The status of each stage of image product and their uses are detailed in the following sections.

Each facility involved in the handling of SIR-A original image and non-image products shall be responsible for their protection against loss and damage. The SIR-A data center shall be responsible for maintaining various logs and other documentation that will facilitate knowledge of the location of all products at any stage in the data generation. All products shall be stored in the SIR-A Data Center at all times, except for periods when they are required for processing purposes, or when they are formally released by the Principal Investigator or assignee. Security control of image or non-image data products is essential to the safety of data products. Three levels of access security are defined as follows:

Level 1: Restricted access. To be stored in a special safe. Access or release for processing (only) by the Principal Investigator or a single assignee. To assure maximum protection of Level 1 products, it is mandatory that they be in the physical presence of a pre-determined

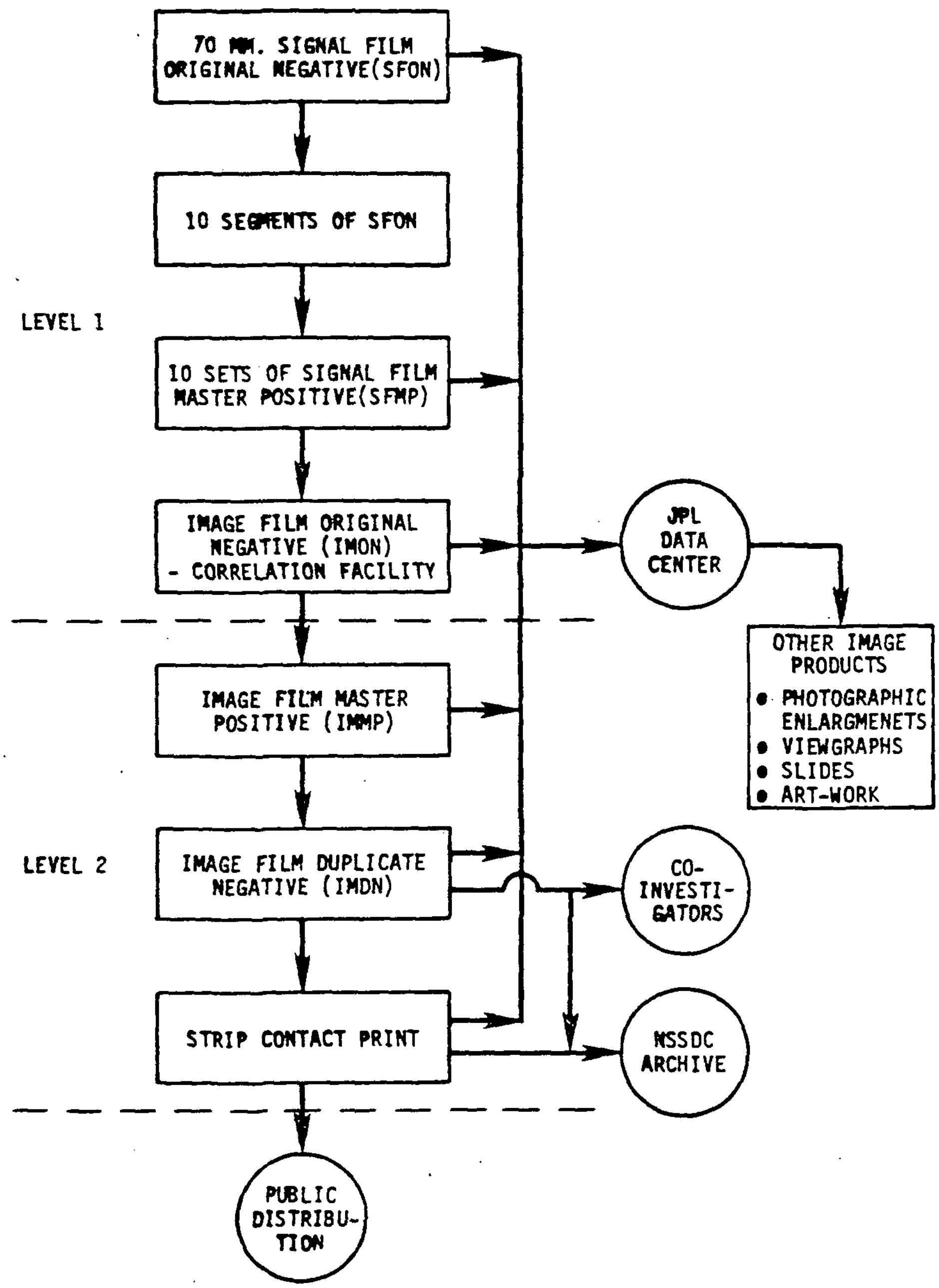


Figure 9.1-1. Image Products Generation Flow

authorized individual at any time that they are not secured in the Data Center safe.

Level 2: Limited access. Storage to be in a locked area. Availability to users via pre-determined access lists; to processing facilities when required. No-return releases by authorization of the Principal Investigator or assignee.

Level 3: Qualified access. Storage in Data Center. Products so designated may be released to any interested parties when available.

9.1.2 SIR-A FILM PRODUCTS

Each U.S. team member will receive one copy of the image film set. The foreign Investigator will receive the coverage only over his sites. One master copy of the image film will be sent to the NSSDC for distribution to the general community by request. No product will be disseminated to other than the Principal Investigator, the Co-Investigators, and the NASA Headquarters official observers without approval of the Principal Investigator and NASA Headquarters. No foreign dissemination (other than to the individual Co-Investigator) is to be made without the approval of the Office of International Affairs. Requests for SIR-A data should generally be handled through NSSDC.

9.1.2.1 Signal Film, Original Negative. All radar photographic image products listed in the following text are derived from the in-flight signal history designated as Signal Film. These data are recorded on a single 70-mm by approximately 3500-foot length of photographic negative film transparency. This product is known as Signal Film Original Negative (SFON). Access shall be Level 1. A Product Traveler form will be initiated at the time of removal of this film from the orbiter film recorder.

Upon receipt of the SFON at the JPL SIR-A Data Center, the appropriate information will be entered on the Product Traveler form and in the SIR-A Product Status Log. A unique File Number will be assigned, noted in the Product Status Log, on the Product Traveler, and the Signal Film container will be so labeled.

Note that with the exception that Product Travelers will be initiated at the SIR-A Data Center instead of the point of origin, all other image and non-image products will be logged and labeled in the same manner as described in the preceeding paragraph.

The SFON will be transported under Level 1 conditions for preprocessing and processing operations.

As soon as the SFON is processed (i.e., developed) it shall be returned to the Data Center under Level 1 conditions, where it will be logged in the Product Status Log and stored in the SIR-A safe until such time that it is inspected and segmented into ten, approximately equal, units under direct supervision of the Principal Investigator. The individual segments shall each be assigned the same File Number as the unsegmented roll with a serially incremented dash or slash number appended, thus giving each segment a unique number.

The segmented units of the SFON will be transported to the Radar Photo Lab, as required, for production of Signal Film Master Positives under Level 1 conditions.

9.1.2.2 Signal Film, Master Postive. The ten segments of the 70 mm Signal Film Original Negative transparency (the aggregate of the ten segments hereafter referred to as a set) will be used to produce ten sets of Signal Film Master Positive (SFMP). The SFMP is a 70 mm positive-image duplicate of the SFON. The Signal Film Master Positive is designated as a Level 1 product.

After production of the sets of the SFMP is accomplished, these products and the SFON shall be transported to the Data Center, where they will be logged in. The Signal Film will immediately be returned to the SIR-A safe.

It is intended that the Signal Film Original Negative set shall be stored in the SIR-A safe until such time that the Principal Investigator orders its removal to another location. Since the SFON is the prime signal history archival record, further use for any purpose is precluded, unless by specific order of the Principal Investigator.

Unique File Numbers shall be assigned all units of the ten sets of the Signal Film Master Positives. Nine sets of the SFMP shall be stored in the SIR-A safe.

The tenth set of the SFMP will be transported to the Correlator Facility, as required, for production of an Image Film Original Negative.

9.1.2.3 Image Film, Original Negative. The tenth set of the Signal Film Master Positive will be employed in the generation of a single set of Image Film Original Negative (IMON). The correlated imagery shall be exposed on a five-inch wide continuous-roll photographic transparency film.

The resultant IMON is designated as a Level 1 product. Immediately after completion of the correlation procedure, the Signal Film Master Positive set shall be returned to the Data Center under Level 1 conditions and stored in the SIR-A safe. The return of this product shall be noted in the appropriate Data Center log.

The IMON may be transported directly to the Radar Photo Lab for development, providing it will be processed immediately; otherwise, it must be stored in locked cold-storage or the Data Center SIR-A safe until such time that processing may be effected. When processing is complete, the IMON set shall be returned to the Data Center under Level 1 conditions, logged in, and inspected by the Principal Investigator. If this inspection indicates unsatisfactory quality, re-correlation will be required; otherwise, unique File Numbers shall be assigned to each of the ten units of the IMON and appropriately logged. Since the Image Film Original Negative set is the prime imagery record, use of this product for any purpose other than production of the Image Film Master Positives (described below) is prohibited, except on express direction of the Principal Investigator. The IMON will be transported to the Radar Photo Lab when required for production of the Image Film Master Positives.

9.1.2.4 Image Film Master Positive. The single set of IMON shall be used to produce two sets of Image Film Master Positives (IMMP). The format of this product, printed on five-inch wide photographic transparency film,

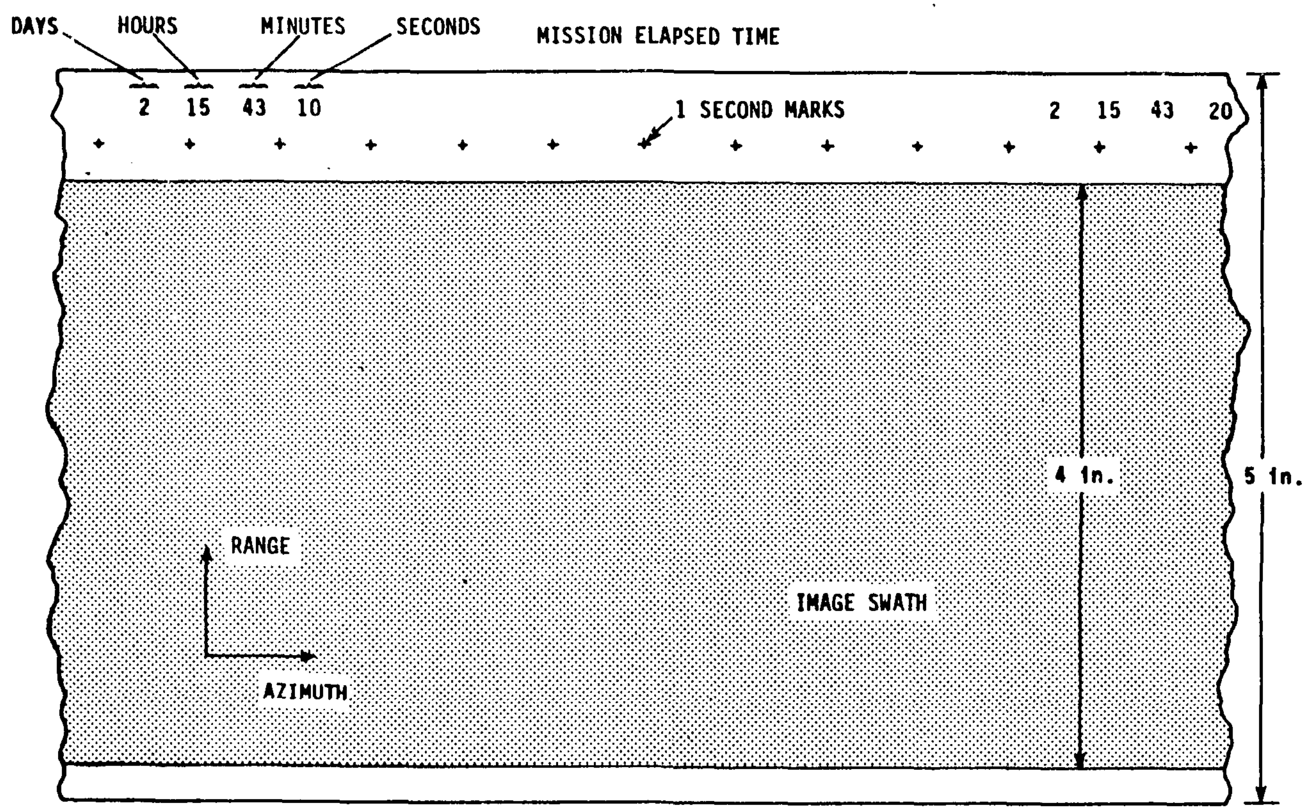


Figure 9.2-1. Image Film Format

shall be a 1:1 positive-image rendition of the IMON. This format is given in figure 9.1-2.

Access to this product is Level 2 (product to be stored in locked compartments). After printing and processing is complete, the two sets of IMMP and the IMON shall be immediately delivered to the SIR-A Data Center. The IMON set shall be logged in and secured in the SIR-A safe. Both sets of the IMMP shall be logged in and assigned unique File Numbers. One of the two sets of IMMP shall be made available for production of Image Film Duplicate Negatives; the remaining set shall be secured in a locked compartment.

9.1.2.5 Image Film, Duplicate Negative. Twelve sets of Image Film Duplicate Negative (IMDN) shall be produced by printing from a set of IMMP. The IMDN is a 1:1 negative-image duplicate on five-inch wide transparency stock of the Image Film Original Negative record in all aspects, and is intended for use as a "working" medium for the production of positive-image data in various forms (i.e., enlargements, positive projection transparencies, etc.).

IMDN is designated as a Level 2 product. Release of this product by the SIR-A Data Center for dissemination or reproduction shall be authorized by the Principal Investigator, or with the approval of the Program Office at NASA Headquarters.

As soon as possible, the Radar Photo Lab shall deliver the twelve completed sets of IMDN and the IMMP set used to produce them to the Data Center. At this time, these products shall be logged in, the IMMP secured, and assuming satisfactory quality, the IMDN sets shall be assigned unique File Numbers. All sets of the IMDN shall be stored under Level 2 conditions until required for distribution or generation of additional products.

At such time as authorized, one set of the Image Film Duplicate Negative record shall be distributed to each of the nine Co-Investigators and NSSDC. The remaining two sets shall reside in the Data Center. One of the sets of IMDN shall be made available to the Radar Photo Lab (or other facilities on authorization of the Principal Investigator) when required for production of various image products.

9.1.2.6 Strip Contact Print. Strip Contact Prints (SCP's) are a 1:1 positive-image rendition in all aspects of the Original Negative or Duplicate Negative Image Films. However, except under special conditions noted above, SCP's will be generated from an Image Film Duplicate Negative set only. Strip Contact Prints are reproducted on five-inch wide continuous-roll photographic paper. SCP's shall be designated as Level 2 products, and shall be handled and stored as such until such time that downgrading to Level 3 may be authorized by the Principal Investigator or assignee. On receipt of an IMDN the Radar Photo Lab shall produce three (3) SCP sets and deliver these products and the IMDN to the SIR-A Data Center. When received in the Data Center, the IMDN and the SCP's shall be logged in, the IMDN secured, and the three SCP sets shall be assigned File Numbers. Two sets of SCP's shall be retained in the Data Center under Level 2 conditions and will be available as references to SIR-A imagery. The third SCP set shall be sent to NSSDC archives. Additional SCP sets shall be printed and distributed as directed by the Principal Investigator or assignee.

9.1.2.7 Other Image Products. Other products such as photographic enlargements, viewgraphs, slides, art-work, etc., will be generated and distributed on receipt of formal requests in the SIR-A Data Center, providing such output has prior approval by the Principal Investigator or assignee and is so indicated on an Authorized SIR-A User List.

9.1.3 SIR-A NON-IMAGE PRODUCTS

Non-image products noted herein are defined as SIR-A related data not containing radar imagery. These products may be in digital, alphanumeric, or graphic form, contained in magnetic tape, computer printouts, microfilm and various catalogs, etc., originated on the Orbiter, at remote sites, or locally (JPL).

9.1.3.1 Real-Time Telemetry Data. SIR-A real-time telemetry data will be received at the JPL SIR-A Data Center from Johnson Space Center (JSC) in three formats: microfiche, magnetic tape, and tabular/table hard copy. The microfiche will be delivered to JPL shortly after receipt of the data at JSC; the tapes and printouts will be delivered approximately two or three months after the end of mission.

9.1.3.2 Real-Time Telemetry Data Log Microfiche. It is estimated that real-time telemetry data will be contained in approximately one thousand microfiche units, consisting of certain flight engineering and ephemeris information extracted from Ephemeris and Data Parameter Telemetry Tapes (see below).

Immediately after receipt at the Data Center, the microfiche shall be logged in and a File Number will be assigned to the "package", rather than the individual units. Access and handling shall be under Level 1 conditions. It shall be the responsibility of individuals handling these materials to keep the package intact and in order. (It is recommended, if feasible, that the microfiche be duplicated and stored in the Data Center for use as a back-up.).

The information contained in the Real-Time Telemetry Data Log is used by the Correlator Facility as inputs for certain correlation operational parameters. The microfiche shall be made available to the Correlator Facility under Level 1 conditions when required and returned to the Data Center for Level 1 storage after logging in.

9.1.3.3 Ephemeris Tape. Mission orbital data will be contained in approximately ten ephemeris magnetic tapes generated at JSC. When received in the Data Center, each tape shall be logged in and a unique File Number assigned. This product is designated as Level 1 and shall be stored as such. Use, duplication or distribution shall be determined by, and at the direction of, the Principal Investigator.

9.1.3.4 Data Parameter Telemetry Tape. Mission engineering data will be contained in approximately ten Data Parameter Telemetry magnetic tapes generated at JSC. When received in the Data Center, each tape shall be logged in and a unique File Number assigned. This product is designated as Level 1 and shall be stored as such. Use, duplication or distribution shall be determined by, and at the direction of, the Principal Investigator.

9.1.3.5 Data Parameter Hardcopy. Mission engineering data extracted from Data Parameter Telemetry tapes in tabular and table hardcopy form will be

generated at JSC and delivered to JPL. When received in the SIR-A Data Center, each unit (if segmented) will be logged in and assigned a unique File Number. (If the data are received as loose sheets, they shall be assembled in binders, with each binder bearing a unique File Number.) This product shall be stored and handled per Level 2 conditions. Duplication and disposition pending approval of the Principal Investigator shall be as follows: one copy each to nine Co-Investigators and NSSDC, two copies retained in the Data Center for reference purposes.

9.2 SMIRR

9.2.1 POST MISSION DATA QUALITY REPORT

A data quality report will be published as a JPL technical document within three months after receipt of the computer compatible tapes, containing SMIRR data, as well as the 16-mm film. The data quality report will comment on the number of cloud-free data takes, the locations, the apparent signal to noise, and any anomalies present in the data.

9.2.2 DUPLICATE PRINTING OF MASTERS

The flight film, both color and black and white, will be duplicated in the JSC photo laboratory. Four duplicates of the original data will be produced. One copy will be archived along with the originals. One copy each will be used by the Principal and Co-Investigators, and a copy will be sent to NSSDC along with a computer compatible tape containing the original and decalibrated data.

9.2.3 ORIGINAL FLIGHT DATA DISPOSITION

The original flight data on the flight tape recorder will be converted to CCTs at KSC. The original flight data will then be erased so that the recorder can be reused. This erasure will take place only after it has been verified that the data has been properly transferred to the CCTs. Duplicate copies of the CCTs will be made for dissemination. The original tape obtained from KSC will be archived at JPL.

9.2.4 QUALITY CONTROL SCREENING

Quality control of the conversion of the flight data to the CCTs will be the responsibility of personnel at KSC. When the tapes are delivered, JPL personnel will scan them and confirm that proper data is on the tapes before the original data are erased from the flight recorder. Screening of the CCTs will be done to show up any bit errors or other omissions on the tapes. Selected samples will be printed out for screening by hand.

9.2.5 DATA DISSEMINATION TO THE CO-INVESTIGATOR

The Co-Investigator will receive copies of all the data produced in this experiment. He will also receive copies of the films as well as prints from selected portions of the film that are to be used in the data analysis.

9.2.6 DATA ARCHIVING

A complete set of tape and film data will be archieved at the Jet Propulsion Laboratory. In addition the original film data and a master copy of the film, as well as CCTs containing the original data and decalibrated data, will be sent to NSSDC six months after receipt of the data from KSC and JSC.

9.2.7 AVAILABILITY OF DATA TO THE PUBLIC

The public will be able to obtain copies of the SMIRR tapes and film by application to NSSDC. The data will be available six months after receipt of the data from KSC and JSC.

9.3 FILE

9.3.1 POST MISSION DATA QUALITY REPORT

A post mission data quality report will be available about two months after the tape recorder is released to the FILE experimenters. This report will include an assessment of instrument operation, number of frames of imagery obtained, quality of the photographic imagery, the distribution of data

relative to feature classes, and the performance of the class-rejection algorithm, which was designed to provide a nearly uniform distribution of data among the four major feature classes.

9.3.2 DUPLICATION OF MASTERS

The flight tape recorder will be dumped and four tapes made at Martin Marietta. Additional tapes will be made at Martin Marietta and at NASA/LaRC, if needed. The flight 70-mm film will be developed and duplicated at JSC.

9.3.3 ORIGINAL FLIGHT DATA DISPOSITION

The original flight tape is an integral part of the tape recorder. The tape recorder will be held at LaRC with the flight data on its tape until the data processing progress clearly indicates that no further need exists for preserving the FILE data within the flight recorder. Then the recorder will be returned to Martin Marietta for reconstructing the FILE experiment as needed.

The original flight photographic film will be stored for 1 year at JSC in controlled humidity and temperature environment. At the end of that year, it will be shipped to LaRC.

9.3.4 DATA DISSEMINATION TO THE CO-INVESTIGATORS

Data dissemination to the Co-Investigators has been described in Section 8.3.1.

9.3.5 DATA ARCHIVING

After the FILE experiment and science team has examined and verified the classification data, a tape of the FILE flight data and a data summary will be furnished to the NSSDC. It is estimated that these products will be supplied to NSSDC about 1 year after receipt of the STS-2 ephemeris data.

9.3.6 AVAILABILITY OF DATA TO THE PUBLIC

FILE data will be available to the public from NSSDC. Also, the FILE results will be published in appropriate conference and journal publications.

9.4 MAPS

9.4.1 POST MISSION DATA QUALITY REPORT

A post mission data quality report will be available about two weeks after the tape recorder is turned over to the MAPS Experiment Team. This will include an assessment of instrument operation, number of hours of data collected, and the quality of those data.

9.4.2 DUPLICATION OF MASTERS

The flight tape recorder will be dumped at DFRC and three copies made. Further copies will be made at LaRC as that becomes necessary. The flight film will be developed and duplicated at JSC.

9.4.3 ORIGINAL FLIGHT DATA DISPOSITION

The original flight tape is an integral part of the flight tape recorder. After the flight tape is dumped and the data quality are verified, the tape will be erased as part of the post flight calibration.

9.4.4 DATA DISSEMINATION TO THE CO-INVESTIGATORS

The flight data will be used to generate a tape consisting of calibrated radiometric signals. This tape will serve as the source tape for the inference of the CO mixing ratio. The CO mixing ratio data will be distributed to the MAPS Science Team in tabulated and map (isopleth) form. The MAPS experiment will be conducted by Principal Investigator Henry G. Reichle, NASA Langley Research Center with the following Science Team: William L. Chameides, Georgia Institute of Technology; W. Donald Hesketh, NASA Langley Research Center; Claus B. Ludwig, Photon Research, Inc., LaJolla, CA; Reginald E. Newell, Massachusetts Institute of Technology; L.K. Peters, University of Kentucky; W. Seiler, Max Planck Institute for Chemistry, Mainz, W. Germany; J.W. Swinnerton, Naval Research Laboratory; and H.A. Walles, NASA Langley Research Center.

9.4.5 DATA ARCHIVING

After the MAPS experiment and science teams have examined the data and verified them, tapes of the raw data, the calibrated radiances and the carbon monoxide concentrations will be furnished to the NSSDC. It is estimated that these products will be supplied to NSSDC approximately one year after the receipt of the final ephemeris.

9.4.6 AVAILABILITY OF DATA TO THE PUBLIC

MAPS data will be available to the public from the NSSDC. Also, MAPS data and results will be published in appropriate scientific journals.

9.5 OCE

There is a growing interest among oceanographers in using ocean color images for studies relating to ocean dynamics. In ocean colorimeter applications, chlorophyll distribution patterns in the open ocean are used as an important indicator of changes in water type which reflect circulation and anomalies associated with the main flow, such as regional upwelling phenomena or meandering eddies. The subtle differences in chlorophyll content in large water bodies of different origin can be traced by this ocean colorimetric technique. OCE data may provide interesting flow pattern images in the Southeastern U.S. Bight, and along the edges of the Kuroshio Current off the coast of the Japanese Islands, the eddies and nutrient upwellings in West Africa, and the South and Central American coast.

Also, chlorophyll analysis algorithms and the removal of atmospheric radiation effects are interesting scientific problems which need to be addressed. A number of articles relating to the subjects of marine biology, ocean flow, remote sensing, and radiative transfer processes involving ocean/atmospheric boundary, will be written and published in the open literature.

This section describes the procedures that Goddard's OCE team will perform from the receipt of the OCE data from KSC to the archiving of the processed data at the National Space Science Data Center (NSSDC) located at Goddard Space Flight Center, Greenbelt, Maryland.

9.5.1 POST-MISSION DATA QUALITY REPORT

A preliminary report on data quality will be made available about 10 days after a duplicate data set is received at DFRC. This will include an assessment of instrument performance, total number of hours of useful data acquired, and a preliminary evaluation of scientific data content.

9.5.2 DUPLICATION OF MASTERS

Formal OCE transfer will occur at KSC upon the Orbiter's return to KSC. However, as a precautionary measure, a preliminary data dump will take place at DFRC immediately after the Orbiter's landing. The dump will be repeated to create two sets of duplicate tapes (see subsection 7.1.5). The OCE raw data in PCM format will not be distributed to Co-Investigators; only the GSFC and KSC teams will have access to the PCM tapes.

9.5.3 ORIGINAL FLIGHT DATA DISPOSITION

The OCE data are recorded on the payload tape recorder and the recorder is the Orbiter's flight instrument. The original flight data stored on the recorder will be erased only after the formal transfer at KSC and the data quality checks have been verified by both OCE and SMIRR teams.

9.5.4 DATA QUALITY CONTROL AND SCREENING

The OCE tapes which are to be distributed to experimenters are in a format which can be readily used in analysis programs, as described in subsection 9.5.1. The data includes extensive document files on timing, specific geographic location information of the data taking, and radiometric calibration constants. The tapes will incorporate the STS-2 ancillary data that will be provided by the mission office. The JSC ephemeris data in BET will be available 14 weeks after the mission is completed. Therefore, the screening of the OCE data quality by the Principal Investigator will have to be completed during this initial 14 weeks.

9.5.5 DATA DISSEMINATION TO THE CO-INVESTIGATORS

OCE has a number of Co-Investigators and experimenters. Current plans are to disseminate calibrated CCTs to all the Co-Investigators and experimenters.

The Co-investigators include:

L.R. Blaine, GSFC.
R.S. Fraser, GSFC.
N.E. Huang, WFC.
H. Van der Piepen, DFVLR.

and the exprimenters are:

P.E. LaViolette, NORDA, NSTL Station, MS
J.A. Yoder, Skidaway Institute of Oceanography
P. Wiebe, Woods Hole Oceanographic Inst.
V. Klemas, Univ. of Delaware
C.R. McClain, GSFC
M. Viollier, University of Lille, France

For those investigators who are not equipped with an image processing system, ultimate chlorophyll gradient images can be made available to selected experimenters. This image can both be saved on magnetic tape (DICOMED tape) or as a photographic image.

9.5.6 DATA ARCHIVING AND AVAILABILITY TO THE PUBLIC

After the dissemination to the OCE team, all the OCE data of acceptable quality will be archived in the NSSDC and will be made available to the public.

9.6 NOSL

9.6.1 POST MISSION DATA QUALITY REPORT

The Data Quality Report will be prepared at the end of 1 week after receipt of duplicate film and tapes.

9.6.2 DUPLICATION OF MASTERS

The duplication of masters of both 16-mm film and video tape will be carried out by JSC.

9.6.3 ORIGINAL FLIGHT DATA DISPOSITION

The original flight data will be filed at MSFC.

9.6.4 QUALITY CONTROL AND SCREENING

Data from the camera and tape recorder will be screened and divided into those portions showing good potential for data analysis and those portions which for reasons of distance, inadequate illumination, sensitivity, etc., appear to be of marginal quality.

9.6.5 DATA DISSEMINATION TO CO-INVESTIGATORS

O.H. Vaughan, M. Brook, and B. Vonnegut are the Investigators who will receive the data. Each Investigator receives film, magnetic tape, astronaut notes, and ephemerides. When synchronization is completed, the 16-mm sound film will be made available to each. Outside investigators will gain access to the data by making requests to O.H. Vaughan at Marshall Space Flight Center. Data will be made available to outside investigators 90 days after completion of the flight.

9.6.6 DATA ARCHIVING

The raw mission data and the synchronized film will be archived in NSSDC. We expect to get the data into the NSSDC at the end of six months. No data will be archived at SUNY at Albany.

9.7 HBT

Because the HBT is not an experiment but an engineering test, no data will be sent to NSSDC.

SECTION 10. DATA ANALYSIS

SECTION 10. DATA ANALYSIS

The processed data is analyzed as described below for each of the experiments to produce useful scientific or engineering results. Estimates of the efforts required and time needed to perform these analyses are also given. The Data Flow Diagrams and Schedules given in Section 8.0 also include the analyses described here. The data analysis is also shown here in HIPO format.

10.1 SIR-A

Two approaches will be used in the analysis of the SIR-A data. These are:

1) In-depth analysis of specific test regions. For these areas the analysis will use SIR-A, Landsat and Seasat (if available) data in conjunction with ground truth, including available geologic maps, and previously acquired airborne data.

2) Survey analysis of the data from different physiographic regions in order to understand the radar signature of a variety of terrain types, covers and features.

The SIR-A investigators have selected a number of regions for which they will concentrate most of their effort. Some examples of their activities are listed in Section 4.1.2.1.

The SIR-A investigators will also look at all the SIR-A data in order to assess the overall quality of the data and identify any highly interesting areas which would require further investigations.

The SIR-A data analysis flow is depicted in Figure 10.1-1.

10.2 SMIRR

10.2.1 ANALYSIS PROCEDURES

The data analysis procedures are as follows:

1. Scan of the complete digital data set to show up anomalies.

INPUT	PROCESSING	OUTPUT
1. o SIR-A 2-D images o LANDSAT 2-D images o SEASAT-A SAR 2-D images (if available) o Ground truth o Aircraft maps o Geologic maps 2. o Physiographic regional radar signatures	o Simultaneous analysis of LANDSAT and radar imagery o In-depth analysis of specific regions o Ground truth comparison o Data quality assessment o Identification of unusual surface areas o Radar image tone identification	o Maps of Earth's surface lineament/texture for selected areas o Geological interpretation maps for selected areas

Figure 10.1-1. Data Analysis Flow for the SIR-A

2. Analysis of the anomalies to separate atmospheric from surface effects.

3. Correlation of anomalous areas with prints of the film data from selection of geologic units from existing geologic maps, and compilation of digital data from each of the chosen areas.

4. Application of statistical and ratio techniques to the data to determine separability of geologic units and the ability to identify minerals.

5. Incorporation of ground truth and atmospheric data to augment the above analysis procedures.

The data analysis flow for the SMIRR is given in Figure 10.2-1.

10.2.2 SUPPORT REQUIRED

Approximately four man-years will be required to reduce and analyze the data during the first year. In addition computer services and travel support will be required.

10.3 FILE

10.3.1 ANALYSIS PROCEDURES

Martin Marietta, under NASA LaRC contract, will reduce the digital imagery data on the FILE 9-track CCT and analyze the data according to procedures that have been developed under NASA Contract NAS1-15602. The analysis will include these tasks:

a. Produce a four-color (one color for each feature class) hard copy of each FILE classification image, based on a processing algorithm identical (as nearly as can be determined) to the electronically programmed algorithm in the FILE.

b. Compare each four-color classification image with the corresponding color photograph obtained from the film camera. Martin Marietta will annotate one set (of the 3 sets provided by JSC) of the FILE color prints to show an outline of the CCD camera field

INPUT	PROCESSING	OUTPUT
o Selected regional data with known geologic units o LANDSAT images o Post-mission data - Ground truth - Atmospheric data	o Application of analysis algorithms, e.g. ratios, principal components, and canonical statistical analysis o Incorporation of post-mission data o LANDSAT image comparison o Digital data scan for anomalies o Analysis of anomalies o Film/map data correlation	Selected area mineralogical species identification

Figure 10.2-1. Data Analysis Flow for the SIMMR

of view superimposed on each print, and then send this set of prints to LaRC. MMA will use the other 2 sets of prints and the two film transparencies (supplied via JSC), in conjunction with any additional pertinent ground truth imagery accessible by MMA or made available by NASA, to make frame-by-frame comparisons of the FILE in-orbit classifications with the photo-interpretative feature classification. From these evaluations, MMA will determine for each scene the accuracy of the real-time (in-orbit) classification by FILE.

c. Perform statistical analyses of the FILE classification data to determine the optimum algorithm for all the FILE data collected on STS-2. These analyses will use previously developed (under NASA contract) tools, i.e., data-clustering displays, data selection capabilities for evaluating misclassification areas and examining imagery data and statistics of those areas, and histograms for the spectral-ratio distribution for each feature class and the statistics for those distributions.

d. Evaluate the FILE performance and accuracy of classification of these preselected parameters:

   - o Spectral band centerpoint selection.
   - o Spectral bandwidth.
   - o Classification thresholds and the scene class rejection algorithm, i.e., the FILE design feature for selecting nearly equal numbers of image for the four feature categories.
   - o Optical settings, including field of view, optical filtering, lens f-number, and shutter speed.
   - o Film selection, including sensitivity, spectral response, and haze-rejection properties.
   - o Resolution, smear, and sun angle.

The Langley Research Center will conduct a parallel FILE data analysis effort, using independently developed data processing and analysis techniques for evaluating the FILE in-flight classification accuracy, any needed algorithm modification and optimization needed for improved classification accuracy, and the photographic data quality. JSC's inputs will be used in making the final evaluation (joint LaRC/MMA) of the photographic performance quality of FILE and the influence of the mission environment on it.

The data analysis flow for FILE is given in Figure 10.3-1.

10.3.2 TIME REQUIRED

A report on the Shuttle FILE results will be complete one year from the time all the data products are available to the Co-Investigators (including Shuttle ephemeris data).

10.4 MAPS

10.4.1 DATA ANALYSIS

The MAPS experiment is not funded to perform data analysis. The MAPS CO data will be processed to yield CO concentrations vs. elapsed time, CO vs. latitude and longitude, averages over particular geographic features, e.g., hemispheres, continents, oceans, etc. The data may also be processed to yield day vs. night averages or correlations with large weather systems.

The interests of the science team members include interhemispheric distribution of CO, the role of CO in tropospheric photochemistry, sources and sinks, and transport phenomena.

As this experiment will provide the first synoptic global data on CO distribution, the precise analytical procedures cannot be defined at this time. Detailed analysis of the contour maps showing the relative variations of the CO concentrations along the ground track might be carried out to detect obvious changes in the CO distribution around the Earth in order to check the agreement with two-dimensional photochemical models. Attempts might be made to correlate the observed data with three-dimensional models combined with chemistry and observed winds and sink

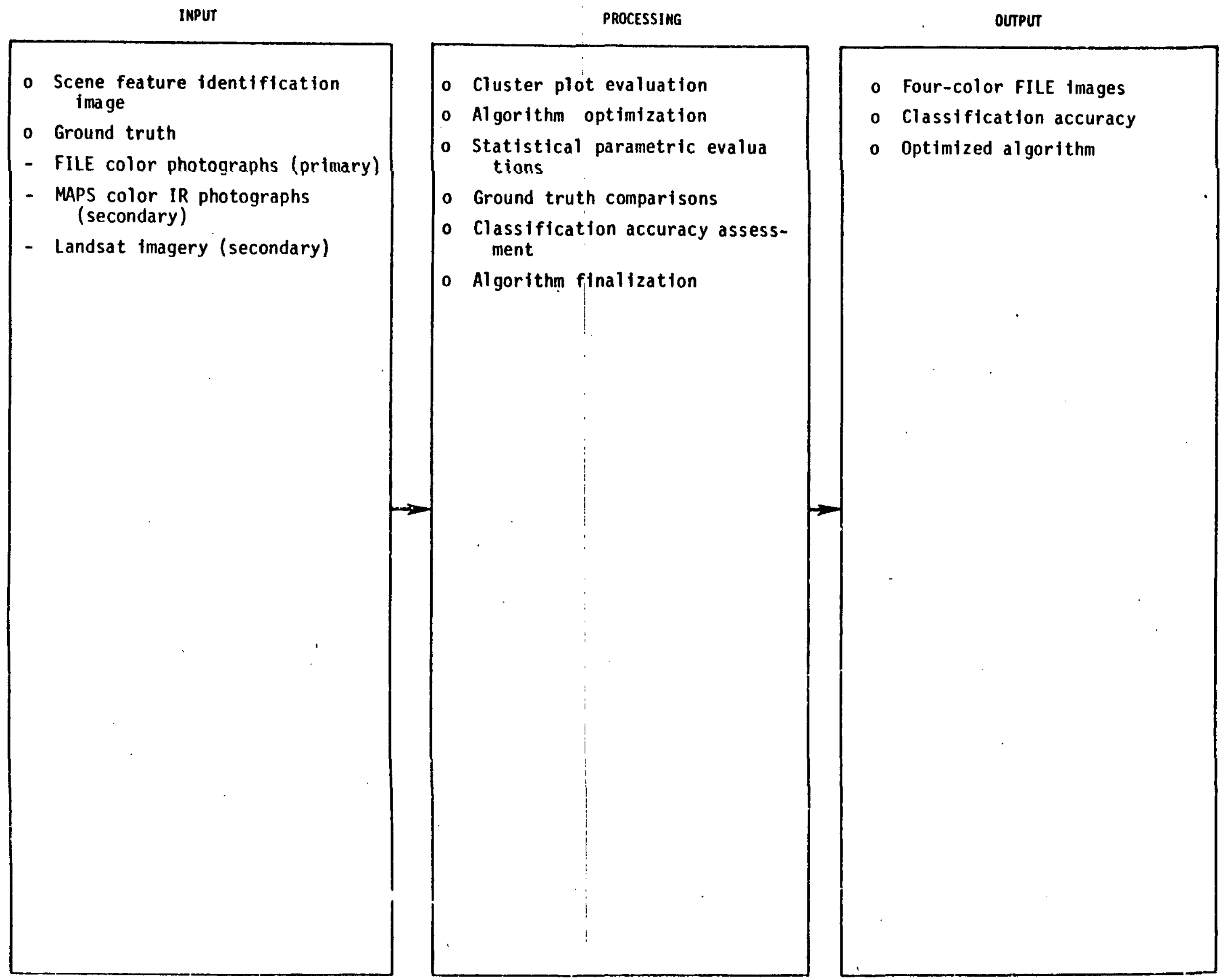


Figure 10.3-1. Data Analysis Flow for FILE

estimates. In addition, the data might be analyzed to determine the total interhemispheric mass transport of CO and what its variation with longitude is. A possible data analysis scheme is shown in Figure 10.4-1.

10.4.2 TIME REQUIRED

These efforts should be complete approximately two years after the flight.

10.5 OCE

10.5.1 ANALYSIS PROCEDURES

The OCE calibrated tapes will be used to produce chlorophyll gradient maps. These maps will consist of images processed by hardware and software available at the GSFC Atmospheric and Oceanic Interactive Processing System (AOIPS) facility. The Goddard team has been successful in deriving chlorophyll images from Ocean Color Scanner (OCS) raw data. The OCS is similar to the OCE.

In this procedure, calibrated CCTs which contain selected geographic areas will be processed on a Goddard Space Flight Center image processing system. The hardware used for this purpose will be the GE Image 100 system used in conjunction with a PDP 11/45 computer. The system allows the user to display multi-channel images of OCE scenes on a video screen and to simultaneously perform various calculations and manipulations upon the displayed data in order to enhance the image and to extract useful information.

Software has been developed for the Image-100 expressly for the purpose of constructing chlorophyll gradient images using OCE data. The technique involves band ratioing of the OCE radiometric data after an atmospheric correction has been made. The result of the calculation is an image of the relative chlorophyll concentration within the ocean scene. This image can both be saved on magnetic tapes and be provided as a photographic image. The magnetic tape is one that can be processed by DICOMED hardware to produce photographic images of the scene. The chlorophyll images can be procured in black and white or color and can be annotated as desired by the user. Figure 10.5-1 shows the data analysis flow for the OCE experiment

INPUT	PROCESSING	OUTPUT
o Contour maps of CO concentrations o 2-3 dimensional chemical models o Models of interhemispheric mass transport	o Detailed analysis of CO concentrations o Comparison of CO results with chemical models o Comparison of mass transport results with models	o Upgraded contour maps of CO concentrations o Modified 2-3 dimensional chemical models o Improved interhemispheric models of CO transport

Figure 10.4-1. Data Analysis Flow for MAPS

and Figures 10.5-2 through 10.5-4 give the detailed algorithms and steps for producing the final chlorophyll maps.

10.5.2 TIME REQUIRED

The times required for the various parts of the data analysis are as follows: the quick-look image will be generated within ten days after removal of the data from the Orbiter. The calibrated radiance tape will be available three to eight months after the flight, the chlorophyll contour images will be developed six to eleven months after the flight, and the in-depth analysis of the OCE data will be completed up to one year after the flight.

10.5.3 SUPPORT REQUIRED

The support required will consist of continuous funding for the data analysis activity for an additional year. This is estimated to be $10K for hardware close-out and $60K for data processing and dissemination during the first twelve-month period.

10.6 NOSL

It is expected that the analysis of the data will be completed by all groups at the end of six months.

The data analysis to be carried out by Dr. Marx Brook and his colleagues at New Mexico Institute of Mining and Technology will be concerned primarily with the study of the photocell data recorded with the NOSL equipment. This data analysis will involve writing out the characteristics of discharges from various storms with a digital recorder and comparing these to similar observations that have already been carried out in studies from the ground and from the U-2 aircraft. These data on the individual discharges will be related to the characteristics of the storm and lightning channel determined from the 16-mm photographic film. In the case in which we are fortunate enough to have simultaneous observations from lightning observatories on the ground, the two sets of data will be carefully correlated.

It is anticipated that the copies of the 16-mm footage and the tape recorded outputs will be available for the investigators in about a month or

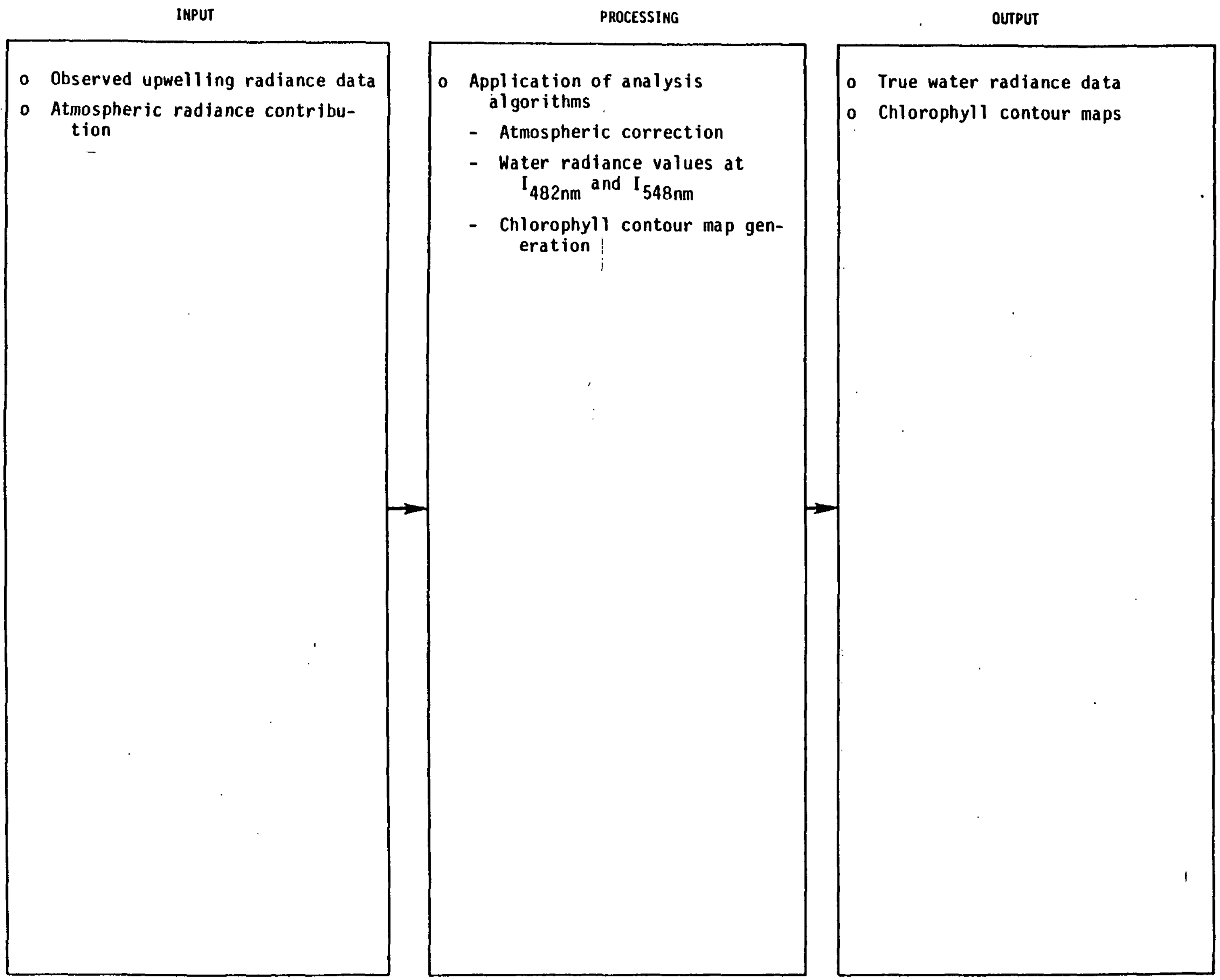


Figure 10.5-1. Data Analysis Flow for OCE

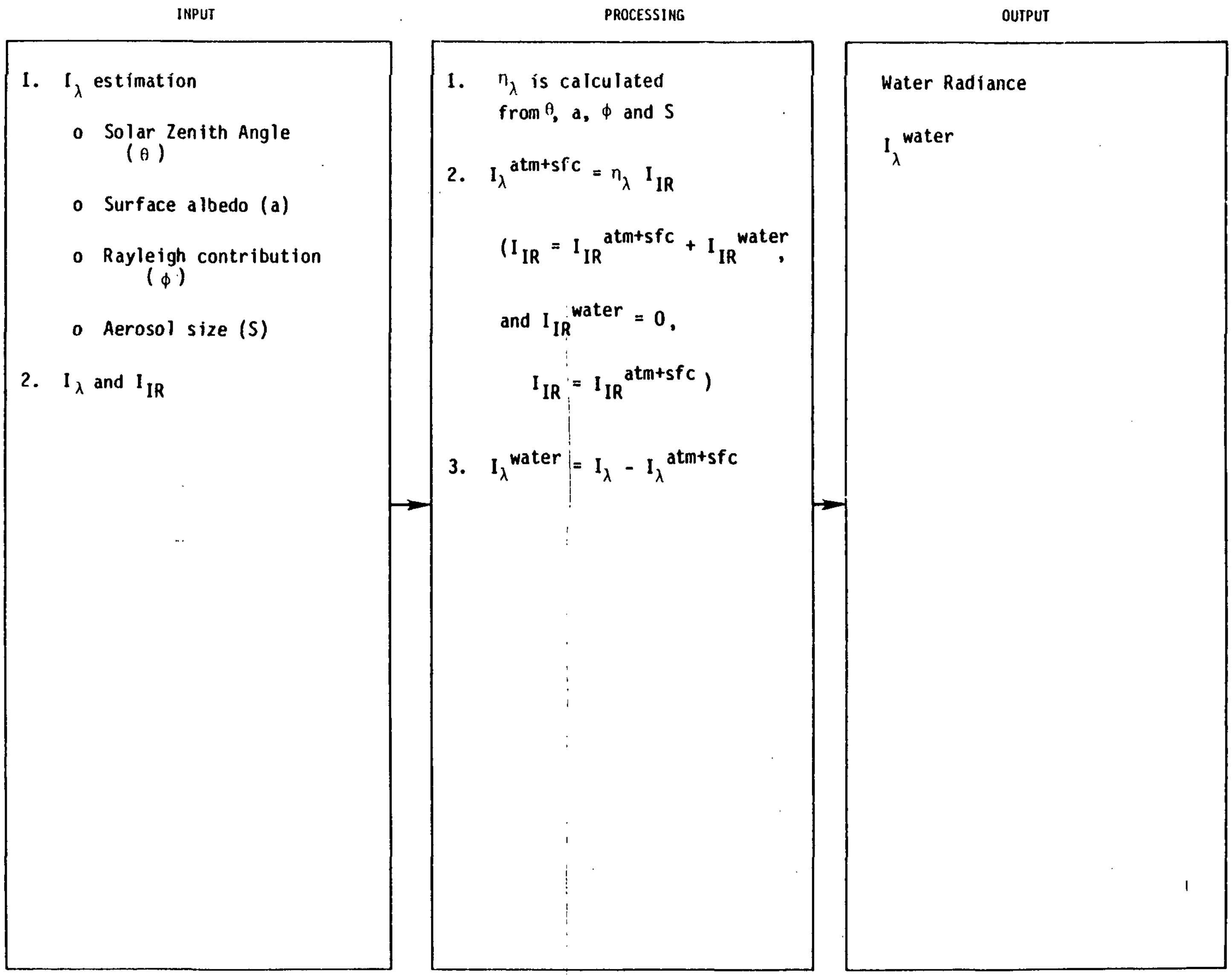


Figure 10.5-2. Correction for Atmospheric Contribution to Obtain True Water Radiance

INPUT	PROCESSING	OUTPUT
o I_{472nm}, I_{548nm}, I_{665nm}, I_{685nm} o I^{water}_{472nm}, I^{water}_{548nm}, I^{water}_{685nm}, I^{water}_{665mn}	$R_{(absorptivity} = \dfrac{I^{water}_{472nm} - I^{water}_{548nm}}{I_{472nm} - I_{548nm}}$ $R_{(emissivity)} = \dfrac{I^{water}_{685nm} - I^{water}_{665nm}}{I_{685nm} - I_{665nm}}$	Chlorophyll Index $R_{(absorptivity)}$ $R_{(emissivity)}$

Figure 10.5-3. Chlorophyll Index R Determination

INPUT	PROCESSING	OUTPUT
1. Chlorophyll index o $R_{(absorptivity)}$ o $R_{(emissivity)}$ 2. Longitude and latitude 3. Time	Contour map generation algorithm (GE-Image 100/ PDP 11/45)	Chlorophyll Contour Map

Figure 10.5-4. Chlorophyll Contour Map Generation

less. The synchronization of the film with the tape recorder output will probably require yet another month or two. The 16-mm film will be reviewed to determine times and locations of lightning discharges and convective clouds. To the extent that is possible, weather maps and satellite data pertaining to these situations will be assembled. In order to differentiate between the precipitation and convective hypotheses of cloud electrification, the film will be analyzed to determine whether lightning discharges are ever observed under stratiform cloud situations. Comparisons will be made to determine the relationships that exist between the lightning flash frequency and the vertical and horizontal extent of convective activity. If a sufficient number of examples is available of lightning-producing cloud systems over land and over sea, comparisons will be made between their convective activities and lightning production. Lightning spectra obtained in night-time photography will be compared with spectral data that has been obtained in the past from cloud-to-ground discharges. It is hoped that there may be sufficient differences evident to serve as a basis for differentiating between intra-cloud and cloud-to-ground lightning. If nighttime photographs show examples of lightning flashes extending in excess of 100 km, a frame-by-frame analysis will be made to determine the rate of propagation of the discharge for comparisons with existing data on stepped and dart leaders, and return strokes.

The magnetic tape recording of photocell optical data will be reviewed for signatures of lightning discharges. These will be graphically displayed for analysis by comparison with photocell optical signatures that have been obtained from the ground and from U-2 airplanes with accompanying slow antenna data. It is anticipated that with such comparisons, it may be possible to differentiate between signatures caused by intra-cloud lightning and cloud-to-ground lightning. An effort will be made to estimate the energy of the lightning discharge on the basis of its photo-optical response. Because the circuit of the present apparatus responds to both the intensity of the change, the discharge and its time rate of change, estimates of the energy of the discharge based on the photocell data will be subject to uncertainty. If observations can be obtained on strong thunderstorm-producing tornadoes, an effort will be made to relate the frequency of the discharge rate to the tornado activity.

NOSL data analysis flow is shown in Figure 10.6-1.

10.7 HBT

Data analysis will consist of observations of the recovered specimens, measurement of their height, and the length of the stem below the cotyledon (hypocotyl length), documentation by photography, and measurements of soil moisture by weight loss upon drying. This should take about one-half day. The HBT data analysis flow is depicted in Figure 10.7-1.

INPUT

- o Lightning images
- o Lightning frequency
- o Lightning spectra
- o Premission data
  - \- Thunderstorm data
  - \- U-2 aircra-t data
- o Post-mission data
  - \- LANDSAT, GOES, and other satellite imagery
- o Simultaneous ground observations (desirable)

PROCESSING

- o Determination of convective energy of cloud system
- o Determination of horizontal and vertical discharge propagation speeds
- o Lightning spectra data analysis
- o Correlation of premission and flight data

OUTPUT

- o Cloud convective energies
- o Lightning propagation speeds
- o Lightning characteristics

Figure 10.6-1. Data Analysis Flow for NOSL

INPUT	PROCESSING	OUTPUT
o Plant length growth o Plant water take-up	o Comparison of final dwarf sunflower height and initial soil moisture content	o Adjustment of amount of water for Helianthus Annuus flight experiment (HEFLEX) on Spacelab-1

Figure 10.7-1. Data Analysis Flow for HBT

SECTION 11. SCIENCE RESULTS REPORTING

SECTION 11. SCIENCE RESULTS REPORTING

A report summarizing scientific results from OSTA-1 will be published by the Program Scientist within 1 year after receiving individual final reports from experimenters. Such a summary report and individual papers from experimenters may be published in summary form in the appropriate technical journal.

The Principal Investigator's plans for their contributions to the Mission Science Report and their plans for publication of results of analysis of data from this mission are stated here.

11.1 SIR-A

11.1.1 MISSION SCIENCE REPORT

A preliminary report will be prepared by the SIR-A team within three months after receipt of the SIR-A film at JPL.

A final report will be prepared within one year after the flight. This report will consist of: 1) the results of the investigations of each investigator and his collaborators, 2) an overall summary of the results from SIR-A including a comparison of the utility of the data in geologic mapping relative to other sensors, and 3) recommendations for future work in the area of spaceborne radar geology.

11.1.2 PLANNED PUBLICATIONS

The SIR-A team studies results will also be published in open literature journals and presented at various conferences.

11.2 SMIRR

11.2.1 MISSION SCIENCE REPORT

The data processing and analysis will proceed in a timely fashion and products will be readied to meet the deadlines of the mission science report as well as other reports required by the project.

The analysis report will contain:

1. Maps of surface coverage
2. Photo-mosaics of areas studied
3. Study of the effect of the variable atmospheric transmission on the value of the data.
4. Linear discriminant analysis results on selected data sets showing the relative importance of the ten spectral bands in separating and identifying surface materials.
5. Study of the usefulness of the ten spectral bands in direct identification of surface materials.
6. Study of the variability of the spectral signature of vegetation in the SMIRR wavelength bands.
7. Study of the correlation of SMIRR results and subsequent ground spectral measurements.
8. Recommendations for spectral bands for a reflight of an improved SMIRR instrument.

11.2.2 PLANNED PUBLICATIONS

Several publications are planned.

a. An experiment description document will be produced as a JPL report by the end of FY 81.

b. A data and experiment description document will be produced to accompany the data being delivered to NSSDC.

c. At least two publications concerning the results from the experiment will be prepared for publication in the open literature during the first year after the flight of OSTA-1. If results warrant, further open literature publications will be prepared.

11.3 FILE

11.3.1 MISSION SCIENCE REPORT

The mission science report for FILE will be submitted within one year.

11.3.2 PLANNED PUBLICATIONS

The FILE results will be published in appropriate conference and journal publications. Two or more papers are planned for publication of results of FILE data.

11.4 MAPS

11.4.1 MISSION SCIENCE REPORT

The preliminary report will be prepared three months after receipt of the data from the orbiter.

It is intended that a considerable portion of the MAPS data will be reduced during the first year after the flight. These data, in the form of CO distributions as a function of location will be made available for the Mission Science Report.

11.4.2 PLANNED PUBLICATIONS

MAPS data and the results of their analyses will be published in the appropriate scientific journals. It is estimated that at least five papers will be published from one to two years after the flight.

11.5 OCE

11.5.1 MISSION SCIENCE REPORT

A preliminary science report will be published about eight months after the Orbiter flight.

11.5.2 PLANNED PUBLICATIONS

Scientifically significant results of OCE data analysis will be submitted for publication in the open literature and in appropriate NASA documents.

Articles published in scientific journals will discuss subjects related to marine biology, ocean flow, radiative transfer processes, and remote sensing of the oceans.

11.6 NOSL

11.6.1 MISSION SCIENCE REPORT

A plan which provides data reports during the mission and shortly after removal of data from the Orbiter is planned. The preliminary findings will be given a month or two after the mission.

11.6.2 PLANNED PUBLICATIONS

The NOSL team studies results will also be presented at symposiums. It is expected that four or five scientific publications will result from the NOSL experiment.

11.7 HBT

11.7.1 MISSION SCIENCE REPORT

Input to the Mission Science Report will be provided within 2 to 3 weeks after data analysis is completed.

11.7.2 PLANNED PUBLICATIONS

If results justify publication, a manuscript will be submitted to a biological journal within 2 to 3 months after the data analysis is completed.

APPENDIX A. ACRONYMS AND ABBREVIATIONS

APPENDIX A
ACRONYMS AND ABBREVIATIONS

A/C	Aircraft
AOIPS	Atmospheric and Oceanic Interactive Processing System
ATF	Automatic Test Function (SIR-A)
ARC	Ames Research Center
BET	Best Estimate of Trajectory
B/W	Black and White
CAP	Crew Activity Plan
CCD	Charge Coupled Device
CCT	Computer Compatible Tape
CO	Carbon Monoxide
COAS	Crew Optical Alignment Sight
Co-I	Co-Investigator
CRT	Cathode Ray Tube
CZCS	Coastal Zone Color Scanner
DAC	Data Acquisition Camera
DFRC	Dryden Flight Research Center
DFVLR	West German Research and Development Institute for Aircraft and Spacecraft
EMI	Electromagnetic Interference
ERPO	Earth Resources Program Office
FILE	Feature Identification and Location Experiment
FMDM	Flexible Modulator/Demodulator (OSTA-1 Pallet)
FOD	Flight Operations Directorate, JSC
FOV	Field of View
GMT	Greenwich Mean Time
GOES	Geostationary Operational Environmental Satellite
GSE	Ground Support Equipment

GSFC	Goddard Space Flight Center
HBT	Heflex Bioengineering Test
HCMM	Heat Capacity Mapping Mission
HHRR	Hand-held Rationing Radiometer
HIPO	Hierarchy Input Process and Output
IECM	Induced Environment Contamination Monitor
IFOV	Instantaneous Field of View
IMDN	Image Film Duplicate Negative (SIR-A)
IMMP	Image Film Master Positive (SIR-A)
IMON	Image Film Original Negative (SIR-A)
IMU	Inertial Measurement Unit
I/O	Input/Output
IR	Infrared
JPL	Jet Propulsion Laboratory
JSC	Johnson Space Center
KSC	Kennedy Space Center
LaRC	Langley Research Center
LeRC	Lewis Research Center
LPS	Launch Processing System at KSC
MAPS	Measurements of Air Pollution from Satellites
MCC	Mission Control Center, JSC
MEA	Main Electrical Assembly (OSTA-1 Pallet)
MET	Mission Elapsed Time
MIT	Massachusetts Institute of Technology
MMA	Martin Marietta Corporation, Aerospace Division
MSFC	Marshall Space Flight Center
MTF	Modulation Transfer Function
MVM	Mariner Venus Mercury
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
NOSL	Night/Day Optical Survey of Lightning

NRL	Naval Research Laboratory
NSSDC	National Space Science Data Center
OCE	Ocean Color Experiment
OCS	Ocean Color Scanner
OFT	Orbital Flight Test
OMI	Operations Management Instructions (Rockwell International)
OMS	Orbital Maneuvering System
OPF	Orbiter Processing Facility
OSTA	Office of Space and Terrestrial Applications
PCB	Power Control Box (OSTA-1 Pallet)
PCM	Pulse Code Modulation
PCR	Payloads Control Room, JSC
PI	Principal Investigator
PIP	Payload Integration Plan
P/L	Payload
PN	Pseudorandom Noise
POCC	Payload Operations Control Center, JSC
PRF	Pulse Repetition Frequency
PTD	Photo Technology Division, JSC
RCS	Reaction Control System
RMS	Remote Manipulator System
RTC	Real-Time Ground Command
SAR	Synthetic Aperture Radar
SCP	Strip Contract Print
SCR	Strip Chart Recorder
SFMP	Signal Film Master Positive (SIR-A)
SFON	Signal Film Original Negative (SIR-A)
SIR-A	Shuttle Imaging Radar-A
SMIRR	Shuttle Multispectral Infrared Radiometer
SMMO	STS Mission Manager Office, JSC
SPC	Stored Program Command
SPIDPO	Shuttle Payload Integration and Development Program Office, JSC
STC	Sensitivity Time Control

STS	Space Transportation System
SUNY	State University of New York
SZA	Solar Zenith Angle
USGS	United States Geological Survey
ZLV	Z-axis Local Vertical attitude

APPENDIX B. HOW TO ACQUIRE OSTA-1 DATA FROM NSSDC

APPENDIX B. HOW TO ACQUIRE OSTA-1 DATA FROM NSSDC

INTRODUCTION

The National Space Science Data Center (NSSDC) was established by the National Aeronautics and Space Administration (NASA) to provide data and information from space science experiments in support of additional studies beyond those performed by principal investigators. In addition to its main function, NSSDC produces other publications. Among these are the Report on Active and Planned Spacecraft and Experiments and various users guides.

Virtually all data available at or through NSSDC result from individual experiments carried on individual spacecraft. The center has developed an information system utilizing spacecraft/experiment/data identification hierarchy.

NSSDC provides facilities for reproduction of data and for on-site data use. Resident and visiting researchers are invited to study the data while at the center. Researchers will be assisted with additional data searches and use of equipment. In addition to satellite data, NSSDC maintains some supporting information that may be related to the needs of researchers.

The services provided by NSSDC are available to any individual or organization resident in the United States and to researchers outside the United States through the World Data Center - A for Rockets and Satellites (WDC-A-R&S). Normally a charge is made for the requested data to cover the cost of reproduction and processing the request. The researcher will be notified of the charge, and payment must be received prior to processing. However, as resources permit, the Director of NSSDC/WDC-A-R&S may waive charges for modest amounts of data when they are to be used for scientific studies or for specific educational purposes and when they are requested by an individual affiliated with: (1) NASA installations, NASA contractors, or NASA grantees; (2) other U.S. Government agencies, their contractors, or their grantees; (3) universities or colleges; (4) state or local governments; (5) nonprofit organizations.

OSTA-1 DATA

A researcher may obtain OSTA-1 data by a letter, telephone request, or an on-site visit. Anyone who wishes to obtain OSTA-1 data for a scientific study should specify the NSSDC ID number, the OSTA-1 mission and the experiment, the form of the data, and the time span (or location, when appropriate) of interest. A researcher should also specify why and when the data are needed, the subject of his work, his affiliation, and any government contracts he may have for performing his study.

NSSDC would also appreciate receiving copies of all publications resulting from studies in which data supplied by NSSDC have been used. It is further requested that NSSDC be acknowledged as a source of the data.

Data products are available in the form of hard copy, digital magnetic tape, film and strip or brush charts. The data can be ordered by indicating the data set form codes which are given in Table B-1.

Data can be provided in a format or medium other than that used here. For example, magnetic tapes can be reformatted, computer printout or microfilmed listings can be reproduced from magnetic tape, enlarged paper prints are available from data on photographic film and microfilm, etc. NSSDC/WDC-A-R&S will provide the requester with an estimate of the response time and when appropriate, the charge for such requests.

Researchers residing in the U.S. should direct requests for OSTA-1 data to:

National Space Science Data Center
Code 601.4
Goddard Space Flight Center
Greenbelt, Maryland 20771
Phone: (301) 344-6695

Researchers who reside outside the U.S. should direct OSTA-1 data requests to:

World Data Center A for Rockets and Satellites
Code 601
Goddard Space Flight Center
Greenbelt, Maryland 20771 U.S.A.
Phone: (301) 344-6695

Table B-1. Data Set Form Codes

Hardcopy

BI 8- x 10-in. books or bound volumes
BT various sizes of books or bound volumes
HI 8- x 10-in. pages
HK 16- x 20-in. pages

Digital Magnetic Tape (Reels)

DD data tape

Microfilm (Reels)

MO 35-mm
MP 16-mm
MT various sizes

Microfiche (Cards)

FR 4- x 6-in. (b/w)

Photographic Film (Frames)

RO 35-mm color slides
UG 4- x 5-in. b/w positives
UI 8- x 10-in. b/w positives
*UM 70-mm b/w positives
*UO 35-mm b/w positives
*UP 16-mm b/w positives
US 5- x 8-in. b/w positives
UT various sizes of b/w positives
UV 5- x 5-in. b/w positives
UW 5- x 47.5-in. b/w positives
UX 9- x 80-in. b/w positives
UY 5- x 12-in. b/w positives
VG 4- x 5-in. color positives
VI 8- x 10-in. color positives
VM 70-mm color positives
VO 35-mm color positives
*VP 16-mm color positives
WI 8- x 10-in. b/w prints

YG 4- x 5-in. b/w negatives
YH 5- x 7-in. b/w negatives
YI 8- x 10-in. b/w negatives
YK 16- x 20-in. b/w negatives
YL 20- x 24-in. b/w negatives
*YM 70-mm b/w negatives
YN 9.5-in. b/w negatives
*YO 35-mm b/w negatives
*YP 16-mm b/w negatives
KYV 5- x 5-in. b/w negatives
YW 5- x 47.5-in. b/w negatives
YX 9- x 80-in. b/w negatives
YY 5- x 12 in. b/w negatives
ZG 4- x 5-in. color negatives
ZI 8- x 10-in. color negatives
ZM 70-mm color negatives
ZY 5- x 12-in. color negatives

Strip or Brush Charts (Rolls)

SO 35-mm
ST various sizes

*This code may have its quantity expressed in feet.

APPENDIX C. ACTUAL DATA ACQUISITION
(TO BE SUPPLIED POST-MISSION)

APPENDIX D. CHARACTERISTICS OF EPHEMERIS DATA AND HOW TO OBTAIN IT

APPENDIX D. CHARACTERISTICS OF EPHEMERIS DATA AND HOW TO OBTAIN IT

The OSTA-1 ephemeris tape will be produced on the UNIVAC 1108 machine and will be seven track, one file, odd parity, 800 bits/inch tape. This tape will consist of Header and Data information. The first 43 records will be Header information and the remaining records will be the Data information. The contents of these records will be as described in the following:

HEADER RECORDS

a. Program constants record. This record will contain physical constants and additional specific data that were used to compute the support data (Table D-1)

Table D-1. Program Constant Record

Parameter	Nominal value	Description
AE	6.378166000D3	Semimajor axis of the Earth's reference ellipsoid Fischer (km)
BE	6.3567842836071070D3	Semiminor axis of the Earth's reference ellipsoid Fischer (km)
EMU	3.986012D5	Mu of the Earth (km^3/sec^2)
ER2KM	6.378165D3	Earth radii to kilometers
OMEGE	4.37526908789526D-3	Angular velocity of the Earth (rad/min)
RADS	6.96495618D5	Radius of the Sun (km)
REM	6.367475142D3	Mean Earth radius (km)

b. Timelines of specified inputs - 40 records. These records will contain only data of interest used in the preparation of the final product.

   (1) IMU misalignments
   (2) IMU drifts
   (3) REFSMMATES
   (4) Onboard time biases
   (5) Onboard time drifts
   (6) Vehicles weights
   (7) Payload bay doors status (closed/open)
   (8) State vectors
   (9) Manuver times
   (10) Drag aerodynamic constants
   (11) Unmodeled perturbations timeline
   (12) Attitude mode timeline.

c. Data format - two records. For tape output, these records will specify the name and location on tape of all the support parameters in the data records.

DATA RECORDS

The format for the data records is specified in Table D-2. The table lists the parameter name, the parameter location, and the parameter definition. Note that the parameter units are kilometers, seconds, and degrees, unless otherwise specified.

Information required for generating the OSTA-1 empheris tape are obtained from two sources. Raw, low-speed, C- and S- band tracking data will be obtained from the Mission Control Center (MCC) through the facilities of the Ground Data Systems Divisions. Selected onboard navigation, attitude and navigation - related pulse code modulation data will be obtained from the Institutional Data System Division (IDSD). JSC will send the OSTA-1 ephemeris tape to the Principal Investigators approximately one to two weeks after Shuttle landing.

Table D-2. Support Data Format

Symbol	Location	Description	Units
GMTY	1		yr (mod 1900)
GMTMO	2		mo
GMTD	3	Greenwich mean time (GMT) ground	day
GMTH	4		hr
GMTM	5		min
GMTS	6		sec
SGMTY	7		yr (mod 1900)
SGMTMO	8		mo
SGMTD	9	Shuttle Greenwich mean time	day
SGMTH	10	(SGMT) onboard	hr
SGMTM	11		min
SGMTS	12		sec
GETH	13		hr
GETM	14	Ground elapsed time (GET)	min
GETS	15		sec
SETH	16		hr
SETM	17	Shuttle elapsed time (SET)	min
SETS	18		sec
XM	19		km
YM	20	Shuttle state vector,	km
ZM	21	Aries mean-of-1950	km
XDM	22	Cartesian coordinate system	km/sec
YDM	23		km/sec
ZDM	24		km/sec
SMAM	25		km
ECCM	26		n.d.
INCM	27	Shuttle orbital elements,	deg
NODM	28	Aries mean of 1950	deg
OMGM	29		deg
TAM	30		deg
XTR	31		km
YTR	32	Shuttle state vector,	km
ZTR	33	Aries true-of-date	km
XDTR	34	Cartesian coordinate system	km/sec
YDTR	35		km/sec
ZDTR	36		km/sec

Table D-2. Support Data Format (cont).

Symbol	Location	Description	Units
ALFTR	37		deg
DLTTR	38	Shuttle state vector,	deg
FPTR	39	Aries true-of-date	deg
AZTR	40	polar coordinate system	deg
RTR	41		km
VTR	42		km/sec
SMATR	43		km
ECCTR	44		n.d.
INCTR	45	Shuttle orbital elements,	deg
NODTR	46	Aries true of date	deg
CMGTR	47		deg
TATR	48		deg
XG	49		km
YG	50	Shuttle state vector,	km
ZG	51	Greenwich true-of-date	km
XDG	52	(geographic) Cartesian	km/sec
YDG	53	coordinate system	km/sec
ZDG	54		km/sec
ALFG	55		deg
DLTG	56	Shuttle state vector,	deg
FPG	57	Greenwich true-of-date	deg
AZG	58	(geographic) polar	deg
RG	59	coordinate system	km
VG	60		km/sec
XMS	61		km
YMS	62	Sun state vector,	km
ZMS	63	Aries mean-of-1950	km
XDMS	64	Cartesian coordinate system	km/sec
YDMS	65		km/sec
ZDMS	66		km/sec
XTRS	67		km
YTRS	68	Sun state vector, Aries	km
ZTRS	69	true-of-date Cartesian	km
XDTRS	70	coordinate system	km/sec
YDTRS	71		km/sec
ZDTRS	72		km/sec
ALFTRS	73	Sun position, Aries	deg
DLTTRS	74	true-of-date polar	deg
RTRS	75	coordinate system	km

Table D-2. Support Data Format (cont.)

Symbol	Location	Description	Units
LATS	76	Sun position, geodetic	deg
LONS	77	coordinate system	deg
ALTS	78		km
XMM	79		km
YMM	80	Moon state vector, Aries	km
ZMM	81	mean-of-1950 Cartesian	km
XDMM	82	coordinate system	km/sec
YDMM	83		km/sec
ZDMM	84		km/sec
XTRM	85		km
YTRM	86	Moon state vector, Aries	km
ZTRM	87	true-of-date Cartesian	km
XDTRM	88	coordinate system	km/sec
YDTRM	89		km/sec
ZDTRM	90		km/sec
ALFTRM	91	Moon position, Aries	deg
DLTTRM	92	true-of-date polar	deg
RTRM	93	coordinate system	km
LATM	94	Moon position, geodetic	deg
LONM	95	coordinate system	deg
ALTM	96		
ORBIT	97	Orbit number	n.d.
SUNF	98	Shuttle sunrise/sunset flag	n.d.
SUNH	99		hr
SUNM	100	Shuttle sunrise/sunset GET	min
SUNS	101	time	sec
BETA	102	Earth/Sun angle	deg
Q1	103		n.d.
Q2	104	Aries mean of 1950 to	n.d.
Q3	105	body coordinate quaternion	n.d.
Q4	106		n.d.
	107	Aries mean of 1950 to	
A		body coordinate tranformation	n.d.
	115	matrix (3x3), row ordered	

Table D-2. Support Data Format (cont.)

Symbol	Location	Description	Units
ALPHU	116	Crientation angles of the	deg
BETAU	117	Shuttle body axes with respect	deg
PHIU	118	to the UVW axes	deg
ALPHG	119	Orientation angles of the	deg
BETAG	120	Shuttle body axes with respect to	deg
PHIG	121	the Greenwich true-of-date axes	deg
XBYE	122	Earth position unit vectors in	n.d.
YBYE	123	body axis coordinate system	n.d.
ZBYE	124		n.d.
XBYS	125	Sun position unit vectors in	n.d.
YBYS	126	body axis coordinate system	n.d.
ZBYS	127		n.d.
XBYM	128	Moon position unit vectors in	n.d.
YBYM	129	body axis coordinate system	n.d.
ZBYM	130		n.d.

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